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Electric Power at Massillon, Ohio

COMBINED ENGINE AND TURBINE STATION RECENTLY RECONSTRUCTED TO MEET THE NEEDS OF A GROWING COMMUNITY; SUCCESSFUL USE OF SUPERHEATED STEAM; CONDENSERS EMPLOYED FOR DOUBLE DUTY

AFTER MANY YEARS of quietude, Massillon, Ohio, a town having a population of approximately 16,000, has suddenly, due to the coming of many new industries, developed into a typical progressive American city and at present possesses all indications of a substantial future growth. On account of the former conditions, the local electric light and power plant which is now owned and operated by The Massillon Electric and Gas Co., was most naturally allowed to deteriorate on account of its environment, the attitude being assumed that as long as the wheels continued to turn, all was well. How they turned, seemed to concern no one.

Things could, however, not continue in this manner and with the purchase of the property by the Henry L. Doherty Co. and the appointment of T. O. Kennedy as general manager and A. V. Wynne as superintendent, a great change came over this system by which the power plant gained materially. New methods of operation tending toward increased efficiency were introduced and, as soon as the necessary funds became available, the greater part of the plant was, during 1914-15, reconstructed so that at the present time Massillon has an electric light and power plant in many respects superior to those of other towns of a like size.

Conforming to the present-day policy of central stations, the transmission and distribution lines of the Massillon company are carried to the surrounding towns and villages of Dalton, Brewster, Navarre, Orville and Fulton. The last 2 towns are served with energy at 22,000 and 11,000 v. respectively, while the others are cared for by the regular 2400-v. primary lines.

All 2400-v. power service and high tension service

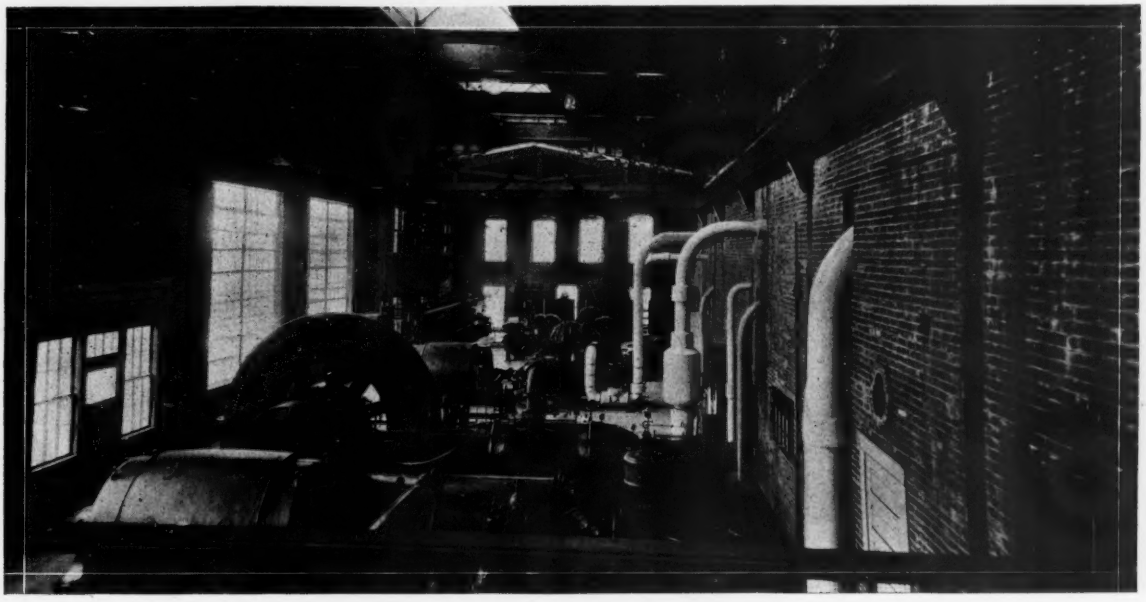


FIG. 7. GENERAL VIEW OF ENGINE ROOM

is 3-phase, while the commercial and arc lighting circuits are single-phase the various phases being taken from the 3-phase bus bars at the station.

Water Supply

Water for steam making and condensing purposes is obtained from the Ohio Canal, which flows through the city. Formerly, water had been taken from the Tuscarawas River, a small stream paralleling the canal; but it was found that this water had such great scale-forming properties that it became necessary, in order to continue operating the plant, either to install an extensive water purifying system or change the source of supply. After considerable study of the matter by the company's engineers, it was decided that the most economical and satisfactory thing to do was to take the water from the canal even though the company be required to pay for this privilege.

Originally, the rate at which this water was paid for was governed by the diameter of the intake opening; but after a short period, it was discovered that this method of payment was extremely unfair, as the rate at which this water was consumed was quite variable so that a part of the time the company was actually paying for water it did not use. To rectify matters, the rate of pay-

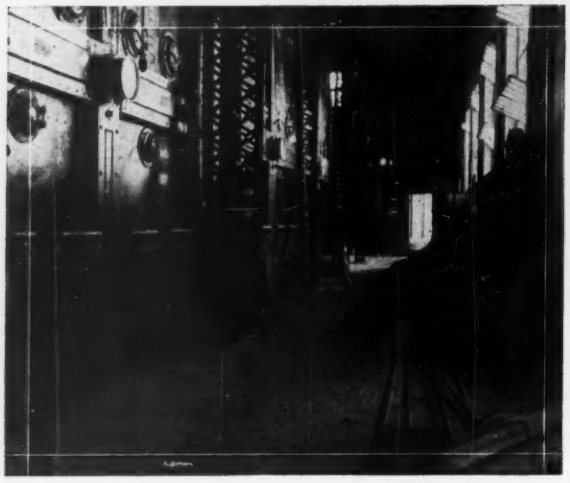


FIG. 1. BOILER FRONTS AND FIRING FLOOR

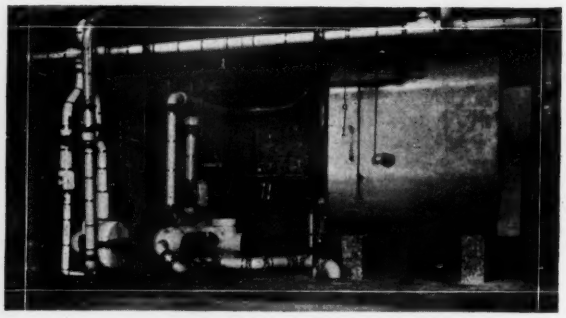


FIG. 2. FEED HEATER PUMPS AND STEAM HEADER

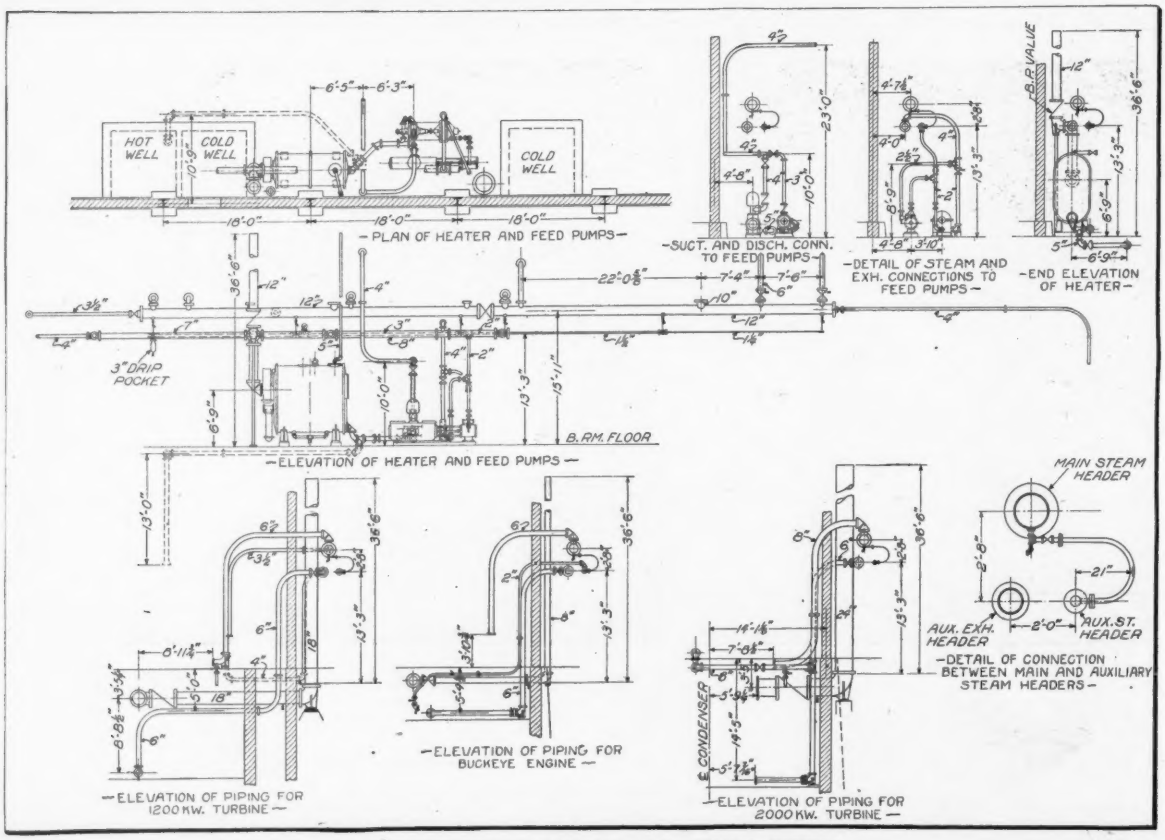

HOT WELL
COLD WELL
COLD WELL
18'-0"
18'-0"
18'-0"
PLAN OF HEATER AND FEED PUMPS
SUCT. AND DISC. CONN. TO FEED PUMPS
DETAIL OF STEAM AND EXH. CONNECTIONS TO FEED PUMPS
END ELEVATION OF HEATER
B.P. VALVE
3" DRIP POCKET
B.RM. FLOOR
ELEVATION OF HEATER AND FEED PUMPS
ELEVATION OF PIPING FOR 1200 KW. TURBINE
ELEVATION OF PIPING FOR BUCKEYE ENGINE
ELEVATION OF PIPING FOR 2000 KW. TURBINE
MAIN STEAM HEADER
AUX. EXH. HEADER
AUX. ST. HEADER
DETAIL OF CONNECTION BETWEEN MAIN AND AUXILIARY STEAM HEADERS
CONDENSER

FIG. 3. FEEDWATER AND EXHAUST PIPING SYSTEM

ment is now based upon the kilowatt output of the plant with a fixed minimum charge.

As shown in the following report of analysis of the canal and river waters, the former contains about ¼ as much solid matter as does the latter, hence the benefit derived from the use of the canal water.

ANALYSIS OF WATER

	River Water	Canal Water
Silica	0.478 Gr.*	0.851 Gr.*
Iron and Alum. Oxides	0.128	0.396
Calcium Sulphate	5.231	1.452
Calcium Carbonate	13.588	8.281
Calcium Chloride	16.836	
Sodium and Potassium Chlorides	22.621	0.437
Magnesium Chloride	3.09	3.166
Loss and Organic Matter	8.47	1.65
Total Solids	62.819	15.595

*Grains per U. S. gallon.

BOILER ROOM EQUIPMENT

ALTHOUGH the space provided for the purpose will permit the installation of at least 8 500-hp. boilers, at the present time there are but 4. One of these is a Heine water-tube boiler rated at 518 hp., while the other 3 are Stirlings, one rated at 416 hp. and the other 2 at 512 hp. each. The last 2 boilers were installed at the time the station was reconstructed and are provided with B. & W. superheaters, superheating the steam approximately 100 deg. F. when the boilers are working at 100 per cent capacity. At loads other than full, the obtainable degrees of superheat are as shown in the table.

Per cent load on boilers	Deg. F. Superheat
75	94
100	100
125	106
150	113
175	120

While this superheat is maintained at the boilers, it is not so great when it reaches the engines; for, when the superheated steam is delivered to the main header, it is mixed with the saturated steam from the other boilers and as a consequence loses some of its heat. Even with this mixture of saturated and superheated steam, the prime movers receive at least perfectly dry steam.

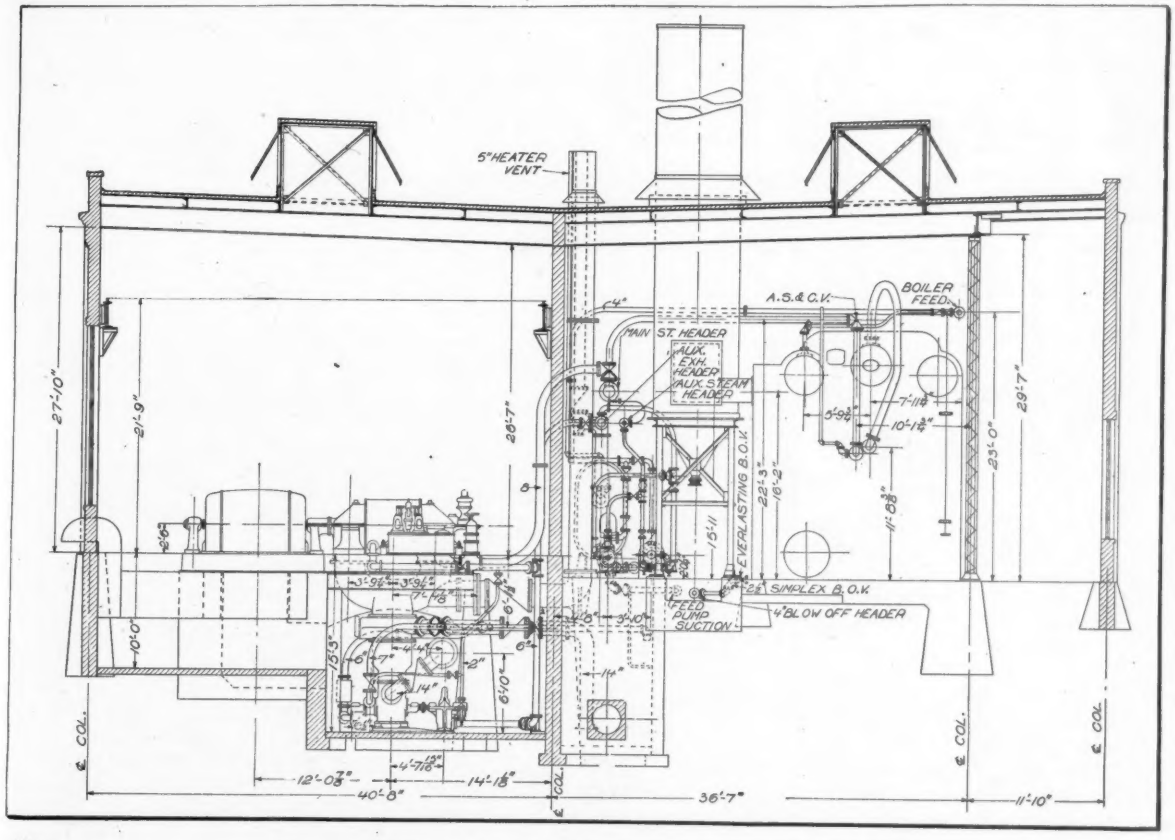


FIG. 4. SECTION OF BOILER AND TURBINE ROOMS AND BASEMENT

It is found that the nature of the scale formed when using the canal water is such that no boiler compound nor any form of scale preventive or remover is necessary. At regular intervals, each boiler is cut out and shut down for repairs and cleaning, at which time a water motor turbine is passed through all of the tubes to remove what little scale may be present.

Slack coal having an average heat value of 12,230 B.t.u. is delivered on the boiler room floor, being shoveled

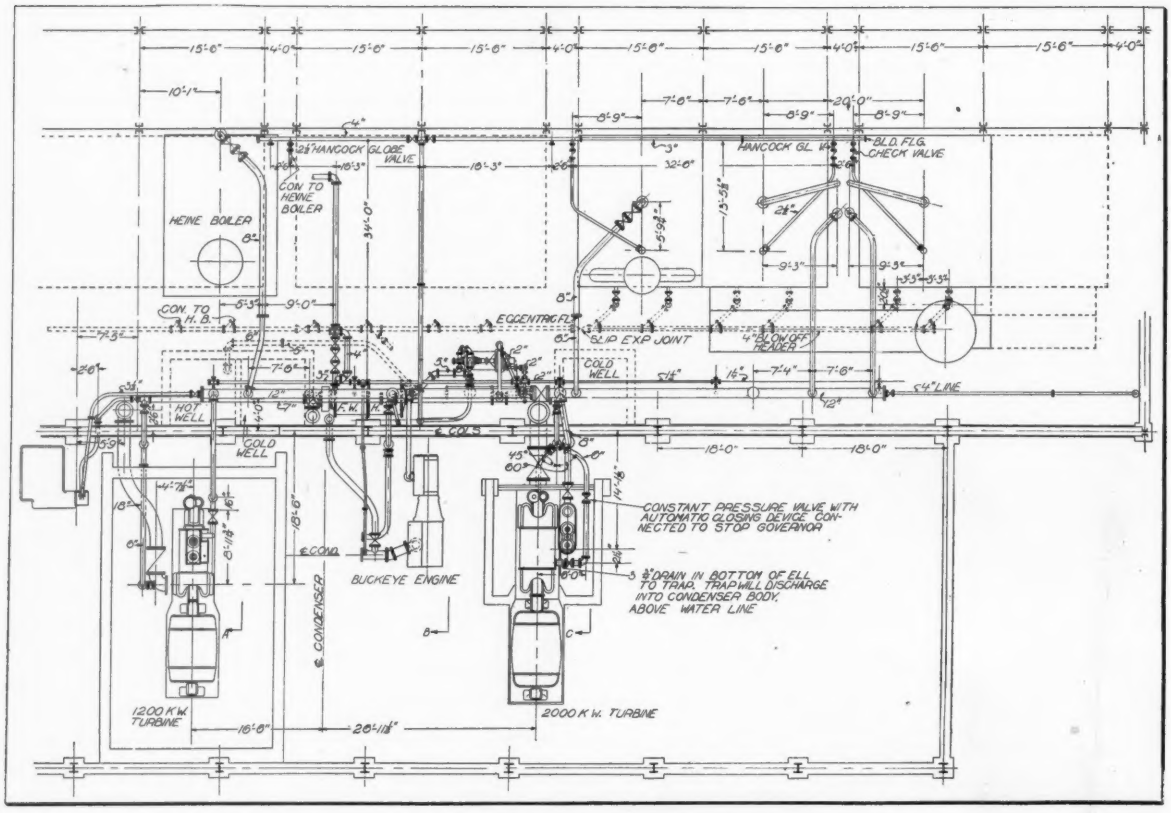


FIG. 5. PLAN OF ARRANGEMENT OF STATION

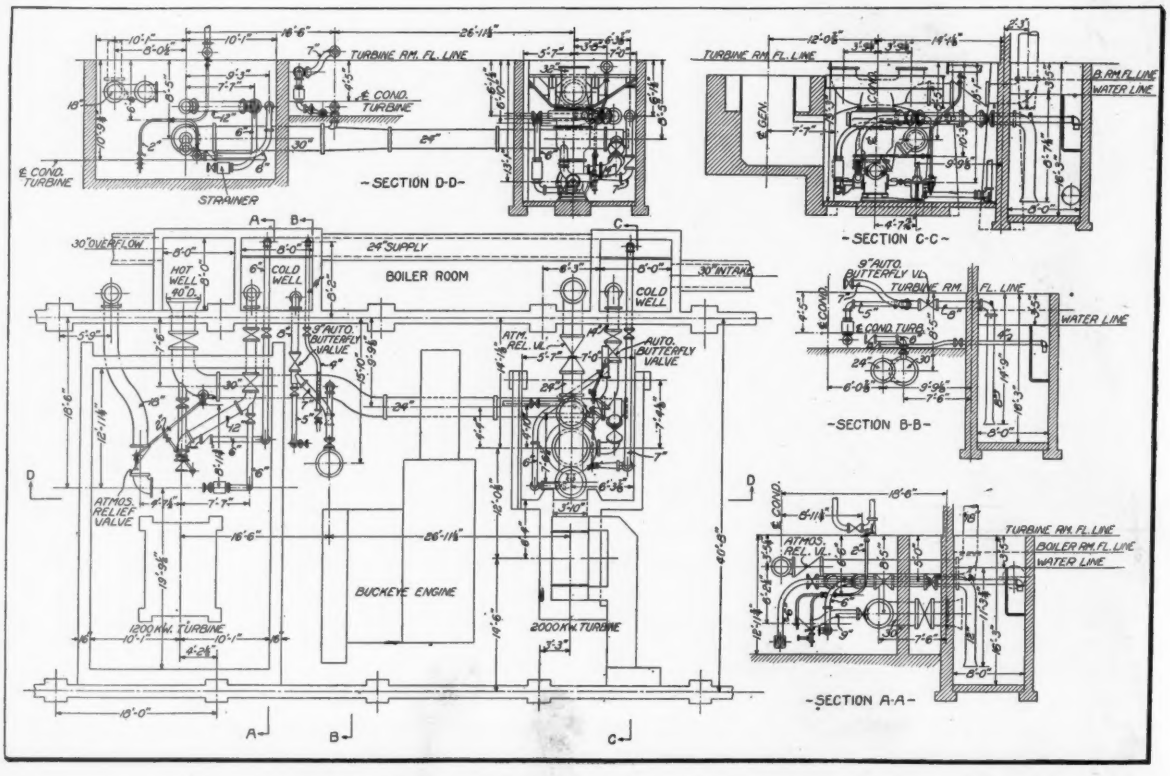


FIG. 6. TURBINE PIPING IN BASEMENT

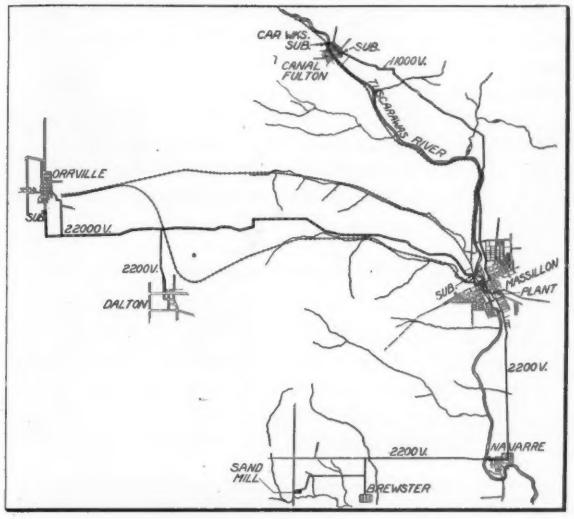


FIG. 8. MAP OF TRANSMISSION LINES TO SURROUNDING TOWNS

from cars run along the outside boiler room wall. From the floor it is fired into the furnaces by hand.

Pressure carried on these boilers varies from 150 to 200 lb. gage, depending entirely upon the units in operation and the load they are carrying.

All steam generated is carried through bends to the main header, which runs along the boiler room wall, whence it is distributed to the various engines, turbines and auxiliary apparatus. The piping, especially that employed in the conveyance of high-pressure steam, is exceptionally well constructed and, wherever possible, bends of a large radius are used. This piping, as well as all flanges and valves, are well covered with an 85 per cent magnesia, sectional covering, which is in turn painted, the color used indicating whether the pipe in question is carrying live steam, exhaust steam, or hot water. The color scheme employed is as follows: Light blue for high-pressure steam, light yellow for exhaust steam, and light green for hot water.

In the boiler room along the engine room wall and directly under the high-pressure header are a Stillwell horizontal sectional heater rated at 4000 hp., the heater

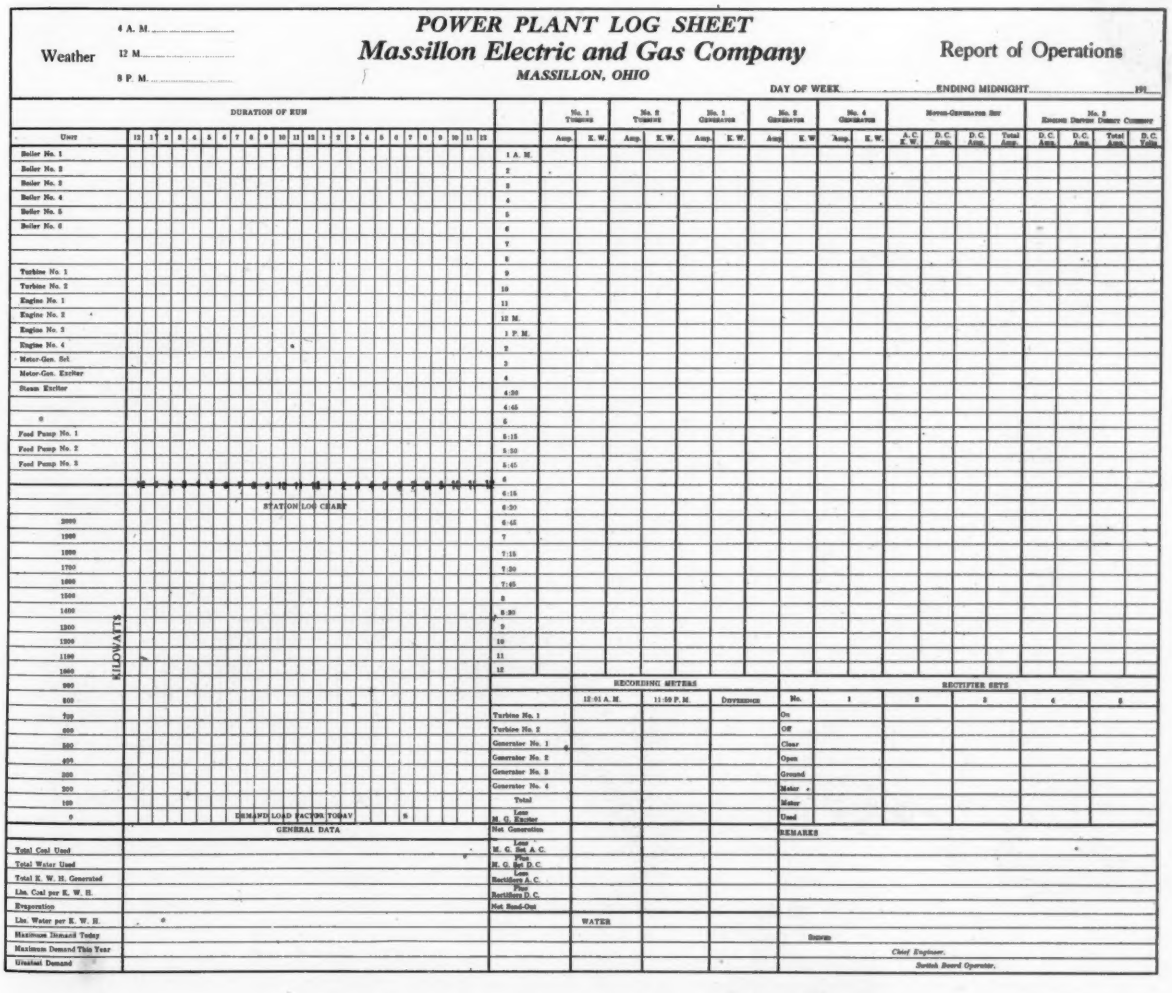


FIG. 9. STATION OPERATING RECORD AND REPORT

feed, boiler feed and house pumps, all of these excepting one of the boiler feed and house pumps being of the centrifugal type.

Figure 1 shows the fronts of the boilers and the firing floor, while Fig. 2 illustrates the feed water heater, heater and boiler feed pumps and a section of the steam header.

When called upon to deliver comparatively large quantities of water all of the feed pumps may be operated in parallel, thus allowing a quantity of water equal to the combined capacity of all 3 pumps to be fed to the boilers if the condition of the load demands so doing.

The house pump used to operate the water turbine for cleaning boilers is provided with a Fisher automatic

FIG. 10. EXTERIOR VIEW OF STATION

pump governor so that the pump is automatically stopped each time the turbine operator closes the water valve when changing from tube to tube or when finished with the work.

Prime Movers and Generators

VARIOUS STAGES in the development of power plant machinery are exhibited in this part of the plant. Some of the equipment used in the original station is still in place, although this machinery is now seldom operated and, according to those in charge, it is the plan of the company to discard this apparatus in the near future.

Of this equipment there are at present 3 Russell tandem compound engines driving by means of rope drives one 150-kw. Wood direct-current, double-voltage generator, one 200-kw. General Electric self-excited alternator and one 200-kw. Westinghouse alternator respectively. In addition to this is a 16½ and 32½ by 36-in. Buckeye tandem compound engine direct connected to a 400-kv.a. Westinghouse alternating-current generator.

The newer units are a 1500-kv.a. and a 2500-kv.a. Westinghouse turbo-alternator, each delivering 3-phase current at 2400 v. and 60 cycles, and exhausting into LeBlanc condensers which maintain an average vacuum of 28½ in.

Excitation for all of the alternating current generators may be obtained from either one or both of 2 exciters, one being an engine driven set while the other is a motor-generator set.

For the possible growth of the station load, space is provided in the engine room for an additional turbine.

All steam from those engines which are not provided with condensers, from pumps and auxiliaries is used to heat the feed water.

Double Duty Condensers

WHEN PREPARING for the turbine foundations, considerable trouble was experienced with large quantities of quicksand, through which a spring developed so that it became necessary, in order to keep the floor of the basement dry, to keep a pump in continuous operation. This, of course, necessitated the purchase of an addi-

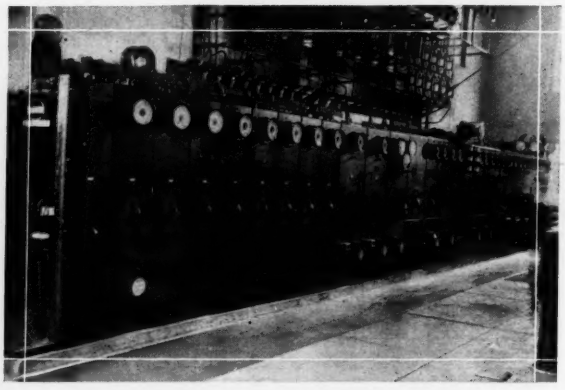


FIG. 11. SWITCHBOARD AT MASSILLON PLANT

tional pump and a considerable consumption of steam. To eliminate the use of this pump and reduce the steam consumption, Chief Engineer W. Wagner conceived the idea of running a pipe of sufficient size from the condensers to the discharge of the spring so that now, instead of using pumps for the removal of this water, the vacuum created by the condensers is employed. By means of a simple system of piping, the water is being continually removed regardless of the condenser or condensers in operation.

Other Electrical Equipment

IN ORDER to supply the small demand for direct current, a 150-kw. synchronous motor-generator set is used, the direct current end of which furnishes either 110 or 220 v. This set serves a double purpose, because in addition to supplying direct current, the field of the motor may be over-excited, causing the motor to draw a leading line current and thereby neutralize the lagging effect of the inductive load.

Figure 11 illustrates the black slate switchboard built up of the regulation motor, generator and feeder panels. All power service panels carry 3-phase apparatus, while the lighting circuit panels carry single-phase instruments and switches. All generator switches are of the remote control type.

Current for light and power is furnished to many of Massillon's industries, the most important of which are the local rolling mills and bridge works, the requirements

of these being such as to have warranted the installation of separate panels controlling independent sets of feeders. This service is supplied at 2400 v.

The Massillon Electric and Gas Co. has the franchise for the lighting of Massillon's public thoroughfares and to provide this service, 5 General Electric mercury arc rectifiers rated at 6.6 amp., 5000 v. direct and 2400 v. alternating current are installed.

Station Records

Complete daily operating records are kept which show not only the station output, but also the length of time the boilers, pumps and various units are in operation. As may be seen by referring to Fig. 9, the time of operation of this equipment is plotted on cross-section paper, as is also the kilowatt load, so that any one glancing at this sheet can readily tell what machines were in operation and the load carried by them at any particular time. These report sheets are made out in duplicate, the original being kept on file at the superintendent's office, while the carbon copy is forwarded to the general manager.

The reconstruction of this station was in charge of E. A. Wilder, one of the Henry L. Doherty Co.'s constructing engineers. It is now in successful operation under the superintendence of A. V. Wynne, to whom we are indebted for information and illustrations in the preparation of this article.

Boiler Feed Water--II

Interesting Experiment Showing Difference in Behavior Between Pure Water and Dense Water; a Study of Density as Applied to Boiler Waters. By F. F. Vater

So far, you have only statements of the effect following a cause, and I will back these statements up with practical experience, so that you, as well as I, will recognize their truth.

Take a beaker of pure water, also another beaker of a water you know is dense. Distilled water can be made dense by adding common salt, to the extent of 0.5 of 1 per cent of the weight of water in the beaker. Place both beakers side by side over a fire that will cause them to boil and watch them. The steam bubbles in the distilled water will be small, will rise to the surface of the water in the beaker and break at once, releasing the steam.

In the beaker containing the dense water, the ebullition will not begin so soon. The bubbles will increase in size and the water in the beaker will rise. The surface of the water will be covered with large bubbles, many breaking at once. You can add more salt to increase the density, until the water will foam over the edges of the beaker. Do this experiment for yourself and you have seen foaming. You have seen in fact, in a small way, just what is occurring in a boiler when it foams.

These large bubbles are a film of water around the steam and when they break, the steam rising will carry small particles of the water film with it, which is the priming that follows foaming. This water film formed from a dense water seems to be tough and elastic to a greater extent than a soap bubble.

Don't think that the foaming resulted because you used salt to make your water dense. It is the density that caused the trouble as you can prove by using suspended matter, salt (which is non-incrusting solid) and carbonate and sulphate of lime and magnesia in combination, to get the desired density. Doing this, you will more nearly parallel your boiler water, as they generally contain all these substances. It will take a water of greater density to foam in the beaker than in the boiler, because low temperatures will be applied and the heat transmission is slower due to a sluggish circulation.

This is absolutely true. It takes a water with a density of 1.005,14 or 300 grains per gallon to foam in a breaker while in a boiler a water of 1.001,97 or 115 grains per gallon will sometimes cause severe foaming and priming.

Some impurities will cause foaming with less density than others; soda ash, for instance.

All of you, no doubt, remember the time you dosed that boiler too heavily with soda ash, as you wanted to clean her up quick. Soda ash will cause foaming quicker than any other impurity I know. We now have proof that density will cause foaming and priming.

It goes without argument that suspended matter will increase sludge. You can take a distilled water, add suspended matter and evaporate all the water off until solids only remain. In a boiler, you are constantly adding more water containing suspended matter, and if you keep up the evaporation long enough, the boiler will eventually fill up with solid matter.

Suspended matter (increased density) will reduce the evaporative efficiency for 2 reasons. Its continual deposition will occur until it is too heavy for the circulation to move. It settles on the plates and tubes acting as a nonconductor of heat. It is partially equivalent to placing a pipe covering between the sheets and the water. This compels the burning of more coal to overcome the insulating effect of the sludge.

Again, the example of the 2 beakers boiling a pure and an impure water has shown that the dense water will not boil as soon as the pure water. It shows, also, that the water film is stronger and this results in an increased coal consumption. It has shown that with pure water the steam bubble rises rapidly and breaks upon reaching the surface, while with dense water, it does not.

The only work of any kind done in this world, is accomplished by the expenditure of heat. You can't shovel coal all day without eating. Your food is the fuel creating the heat, which permits you to work.

If a steam bubble due to the increased weight of water around and above it must work harder to get to the surface and release its steam, it must be supplied with the necessary energy from your coal pile. The percentage of heat lost in doing this necessary but wasteful work, will vary with conditions, and therefore, can only be expressed after a trial or test.

Eventually, it will be taken into consideration and (the exact loss once determined) we will open our eyes at its extent.

Show me a plant burning 6 or 8 lb. of coal per horsepower hour, and I will show you they are using bad water; 6 or 8 lb. of coal per horsepower, sounds impossible, but there are many plants doing no better and some are worse.

Suspended matter accumulating in a horizontal boiler has burned or bagged many a boiler shell. The fact that it burns out tubes is not so generally recognized. The burning of tubes is generally found in water-tube boilers. Have you ever had a tube bulge out and split open on you, with no scale in the tube and no oil to form oleate of lime, which is so sticky, the circulation cannot move it? It is density, pure and simple. If a tube bulges from scale or oil, it will bag at one place or at several places in the one tube, but when density causes the trouble, it will bulge around the entire circumference of the tube and split open whether the tube be lapwelded or seamless drawn.

In a case which I inspected a short time since, the tube had bulged out until it rested against the surrounding tubes opening up in front where there was nothing to support it. The split was 14 in. long. The boiler was cleaned 18 days prior to the accident. The damaged tube was clean. There was no scale to speak of.

In order to determine exactly what the cause was, I analyzed the feed water, analyzed the water after it passed the heater to determine how much of the boiler supply was returned condensation, and analyzed the water in the boiler just before it was blown down, which was scheduled for every 8 hr.

The water leaving the heater had 15 grains of incrustants per gallon, a density of 1.000,26. The water in the boiler had 160 grains of impurity, or its density was 1.0027 plus.

It was really worse than this, because the blowoff was sealed so that we could not get a sample except from the water gage cock. It, therefore, does not include the density due to the heavy precipitate which would remain in the lower drum, and which would have shown, could we have taken the sample from the blowoff cock.

Why was it density? We have seen the formation and action of the dense water in the beaker; how much larger the steam bubble was, how they seemed to gather together in colonies.

This in the open beaker. In the tube, these colonies get together and fill the entire tube until there is a very large bubble dividing the water in the tube into 2 sections, splitting the circulation; in other words, there being no water in the tube at this point to absorb the heat, it soon became overheated and burst. You can't damage a tube without overheating. It can be overheated only when, through some cause, the water is kept away from the metal so that it cannot absorb the heat. Scale will do this in spots, oil in the feed water will do it in spots. An improper furnace construction, so that a blowpipe effect is produced, will split the circulation, as will density.

Density is generally the cause because with improper furnace construction, the trouble will occur at one place in the boiler, while, when density is the cause, it will occur the second time at some other point. Occurring in one place several times, would cause a correction of the defect to be made promptly.

This case is not one of suspended matter, however, as the water was very clear. Suspended matter in like quantity would have produced the same result. The cure for suspended matter alone without other impurity is sedimentation, filtration or both,—both only when the quantity to be removed is sufficient to cause trouble with a filter, frequent washings and much care.

I want to caution you against one thing. If you use a filter to remove suspended matter from boiler feed water, do not under any circumstances, waste time and money by feeding a coagulant, such as alum.

Filter alum is a sulphate of alumina; contains sulphuric acid, which is released when the alum is dissolved and enters the water. If lime is not present in the water in sufficient quantity to absorb the sulphuric acid, you will have corrosion or pitting. If the lime is present, you are simply forming calcium sulphate, which is the one impurity you especially desire to keep out of your boilers.

Having told the ill effects caused by suspended matter, it is but fair to tell a good effect if it exists, and there is one condition where suspended matter is a distinct benefit.

Calcium sulphate, gypsum, plaster of paris; 3 names but one substance. It is a binder or cement. If you wanted a white cement that would be hard and set quickly, you could use plaster of paris. To just the extent that you added some foreign substance, the resulting cement would be softer and it would set slower. Therefore, in a water containing calcium sulphate to the extent that it also contains suspended matter, the scale in your boiler will be that much softer and more easily removed. This means a saving in coal, because an open porous scale is not the insulator against heat that a dense hard scale is, nor is there the danger of burning a boiler.

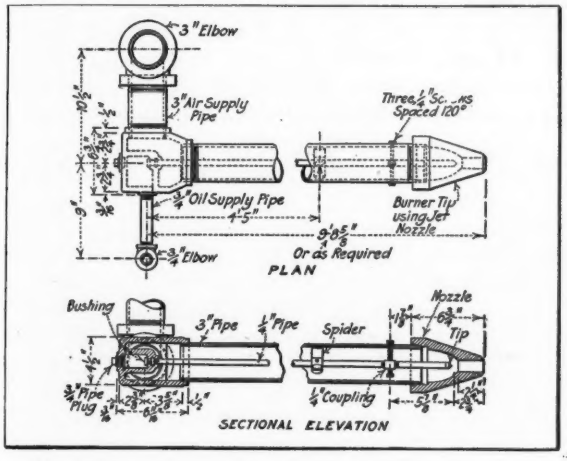
(To be continued.)

Low-Pressure Oil Burners

IN the accompanying figure are shown the essential features of low-pressure oil burners used on the reverberatory furnaces of the Steptoe Valley Smelting & Mining Co., McGill, Nev., as described by R. E. H. Pomeroy in the Bulletin of the American Institute of Mining Engineers. The air for these burners is supplied at a pressure of only 40 oz. by a motor-driven Connersville blower of 42-cu. ft. capacity per revolution. The oil is crude petroleum having a specific gravity of 16.5 deg. Be., flashing in open test at 199 deg. F. The oil is heated to about 200 deg. F. in a steam heater before going to the furnace, about 9 b.hp. per furnace-day being required to heat the oil from the line temperature to the burning temperature. The oil is fed by gravity, 34 lb., static pressure, through 7 burners.

The No. 2 reverberatory furnace, on which a series of tests were made, has the following dimensions at the skimming line: Length, 132 ft. ½ in.; average width, 18 ft. 10 in. The air supplied to the burners for atomizing and burning the oil amounts to about 10 per cent

of the theoretical air necessary for complete combustion, the remainder of the necessary air enters the furnace through the burner openings in the firing wall. No checker holes are provided and the charge holes in the roof are equipped with slide gates and "dog houses" to minimize air leakages. The combustion of the fuel



LOW-PRESSURE OIL BURNERS—STEPTOE TYPE

is practically complete, the carbon monoxide in the effluent gases being less than 0.5 per cent. The draft at the firing end of the furnace is 0.18 in. of water; in the uptake above the "verb" the draft is about 1 in., and in the stack 1.4 in. The top of the stack is about 320 ft. above the skimming line of the furnace.—Compressed Air Magazine.

The Fireman's Efficiency

MAN IN CHARGE OF BOILERS NOT ALWAYS RESPONSIBLE FOR LOW RATE OF EVAPORATION; HEATING VALUE OF COAL OF VITAL IMPORTANCE. BY CARLETON W. HUBBARD

THE editorial "Fundamental Economy in the Steam Power House," in the issue of May 15, 1915, was read by me with great interest. I concur heartily in the statement that the fireman is one of the poorest paid men on the staff, that his duties are arduous and complex, and that he should not be blamed for all wastes and inefficiencies regardless of who causes them. As the majority of steam plants work, it is physically

FIG. 1. RESULTS OF TESTS CONDUCTED SHOWING THAT WITH PRACTICALLY CONSTANT EFFICIENCY, EVAPORATION VARIES WITH CHANGE IN HEATING VALUE OF FUEL

Test No.	Per Cent Ash	B.t.u. as Fired	Evaporation Lb. Water per Lb. Coal	Per Cent Efficiency
1	13.46	12476	7.1	61
2	11.08	12905	7.6	63
3	10.67	13100	8.0	65
4	9.84	13353	8.5	69

impossible for the fireman to know what becomes of the steam after it leaves his boiler, and moreover, the use of steam in the plant is a matter for which the management and not the fireman should be responsible.

After a man has been firing a 12 or even an 8-hr. watch, he is something of a superman if he has any inclination to investigate the use of steam in the factory that his boilers supply, even supposing that he would be allowed by the management to do so, or that the plant was operating after his day's work was done.

Now, as to evaporation being the only figure by which a fireman should be judged, I must state that in my opinion, such an attitude is extremely unfair. The fireman who has any means of knowing the intensity of the draft in his boilers is a rarity, while one who has at his command an instrument showing the efficiency of combustion as indicated by analyses of flue gases is almost

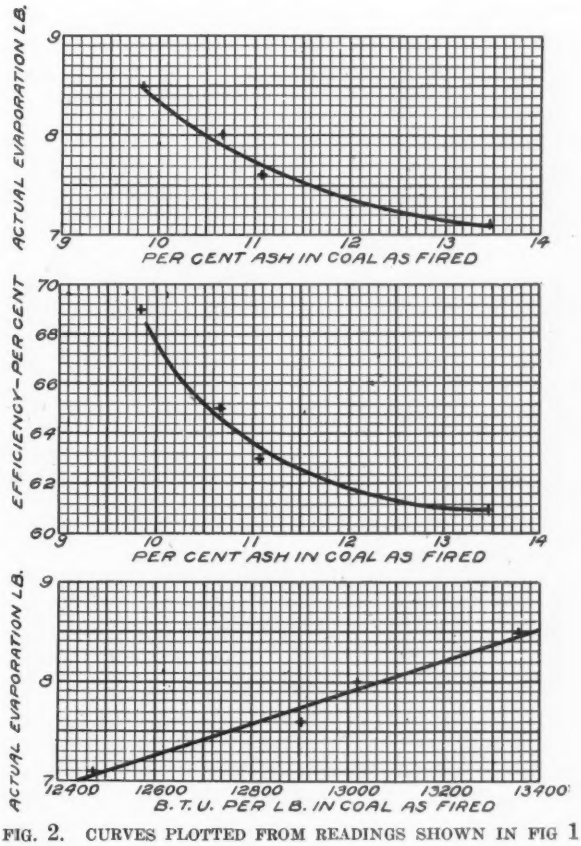


FIG. 2. CURVES PLOTTED FROM READINGS SHOWN IN FIG 1

a curiosity. What good does it do the fireman to know that he is getting an evaporation of 8 lb. if he has no way of finding out whether 8 lb. is all right or he should be getting 8½ or 9? If you have ever experimented with dampers on boilers which are equipped with draft gages, you must have discovered that with the damper in some positions a slight shifting of the damper will produce a large change in the intensity of the draft, while in other positions the damper can be moved through quite a large range and produce a slight change in the intensity of the draft. Furthermore, if you have ever done any boiler-room work, you must know that for every load there is a thickness of fire and intensity of draft that will produce the best results. How is the fireman going to know whether he is right or not if he doesn't have some way of knowing whether he has attained these conditions?

If you have ever had your coal tested, you must have noticed that there will be rather wide variations in its heating value and quality as shown by the ash and sulphur contents even when ostensibly the same grade of coal is being delivered. In some cases, a different grade of coal has been deliberately substituted without any notice of such change being given to the purchaser. Is it fair to make the fireman responsible for these changes? When it is remembered that to evaporate a pound of steam approximately 1000 B.t.u. are required, would you blame the fireman if his evaporation fell off without having some means at hand to determine whether he has been handed as much heat as before in the form of coal?

With a given coal, it does not require a much higher percentage of ash to reduce the heat by 250 B.t.u. which is roughly equivalent to a quarter of a pound of water. There would be no outward indication of a small increase in the percentage of ash, and yet the fireman who was getting an evaporation of say 9.5 lb. with coal having 14,200 B.t.u. as fired, would be expected to obtain an evaporation of 9.5 lb. if the heat in his coal fell off to 13,950 B.t.u. per lb. as fired. That doesn't seem exactly a square deal.

I agree that to maintain a constant rate of evaporation is no sinecure, especially when the foregoing facts are considered, and I fail to see how it is even an indication of efficiency. If the efficiency is kept constant, the evaporation will vary with every change in the heating value of the fuel, but unless the quality of the fuel remains constant, the efficiency does not and should not remain constant. The results of the tests shown in Figs. 1 and 2, for which I am indebted to Hubert E. Collins, who conducted them, are good proof of the foregoing points:

"Pounds of water per pound of coal" is all right when accompanied by sufficient information to make it mean anything, but a much better boiler-room ideal is "the largest possible amount of the heat in the coal transmitted to the water in the boiler."

How to Apply Belt Dressing Safety

By N. G. Near

"WHILE putting some dressing on a belt one day this week Jack Warren suffered a broken finger, the belt drawing the member into the wheel. Mr. Warren managed to jerk his hand out of the wheel, which was fortunate, as he might easily have suffered more serious consequences."

The above news item should serve as a warning to those who think they can do what they themselves would warn others not to do.

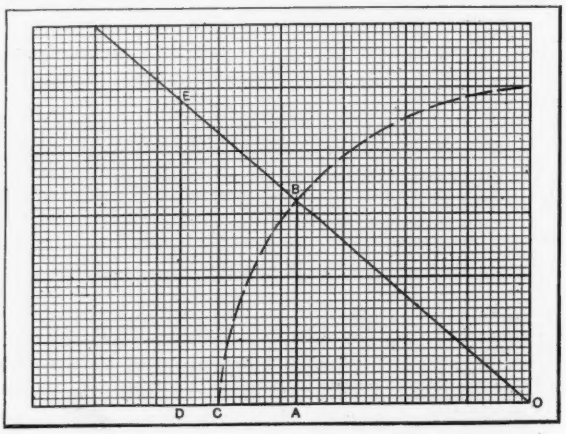
Jack Warren has worked with belts and pulleys for many years, yet he finally got caught.

A safe way to apply belt dressing is to put it on the end of a stick and stand away at a safe distance. If the dressing is liquid, fasten a cloth at the end of the stick, dip in the liquid, and then apply. If "stick" dressing, fasten the "stick" to the stick.

Never imperil your hands or arms.

Substitute for Proportional Dividers

THE copying of a drawing to a reduced scale can readily be done without the use of proportional dividers. The device for doing this work is made from a piece of cross-section paper. First, lay off any horizontal distance, *OA*, and then find a radius, *OC*, so that the ratio of *OC* to *OA* is equal to the ratio of reduction required; with this radius strike an arc, *CB*, of indefinite length. Then at the point *A*, erect a perpendicular intersecting the arc at *B*. Now draw a line through points *B* and *O*. This gives the means of making the reduction. To use the device, take off a distance on the large drawing with the dividers. Assume that this distance is equal to *OE*. Lay this off on the diagonal line, then the required distance reduced to scale will be found by dropping a perpendicular to *D*. This can be done with the aid of the vertical lines on the cross-section paper without any construction. *OD* is then the required distance. The basis for the method is the geometrical theorem that similar sides of similar triangles are proportional.—Sidney K. Eastwood, in Machinery.



CROSS-SECTION PAPER USED FOR MAKING PROPORTIONAL DRAWING

Arthur K. Ingraham, 78 yr. old and 45 yr. a salesman in the employ of the Joseph Dixon Crucible Co., of Jersey City, N. J., received a long letter recently from his friend "Uncle George" Olney, in which the latter relinquished his claim to the title of Dean of Traveling Salesmen on account of his retirement over a year ago from active service with the Irving Pitt Manufacturing Co., of Brooklyn, N. Y. Mr. Ingraham is 2 yr. the junior of his friend "Uncle George" and in a photograph taken 2 yr. ago at a convention of the National Association of Stationers, he stands erect with a look of mental keenness which promises the satisfaction of holding for several years to come his newly acquired honor. Both Mr. Ingraham and Mr. Olney have been connected with the stationery trade during their entire combined service of over a century—a decade over for good measure.

Fire Brick for Boiler Settings*

CHEMICAL COMPOSITION, MANUFACTURE AND USE. BY WILLIAM A. HEISEL†

BY FIRE brick we mean that refractory material composed of fire clay or a combination of fire clays, as distinguished from such heat-resisting materials as silica, bauxite, chrome, magnesite, graphite and the various other special refractories.

COMPOSITION, FORMATION AND LOCATION OF FIRE CLAYS

PURE FIRE clay is called "kaolinite" and consists of about 40 per cent of alumina, 46 per cent of silica and 14 per cent of combined water. It is formed by the decomposition of the mineral feldspar. It is the opinion of some geologists that it is then washed from its place of formation and acquires in its travels various impurities, such as iron, lime, magnesia, alkalies, soda and potash, together with more or less organic material. This washing of kaolinite and the acquisition of impurities result in the formation of one of the 2 general classes into which fire clays are divided, namely, soft or plastic clay.

The origin of the other class, flint clays, has not as yet been determined. There exists what is termed a semiflint clay, the formation of which is another question disagreed upon by various geological authorities. Some maintain that it is formed by the weathering of flint clay, while others contend it is due to increased pressure on a body of plastic clays.

Among the states in this country the most important fire clays are found in Kentucky, Pennsylvania and Missouri. Fire clays are usually found associated with coal, sandstone or limestone measures.

PHYSICAL AND CHEMICAL PROPERTIES OF FIRE CLAYS

FLINT CLAYS are purer chemically than plastic clays, due to the difference in their formation. The flint clays have practically no plasticity, while the plasticity of the plastic clays varies from slight to highly plastic. The intermediate or semiflint clays might be considered the transition point between flint clays and plastic clays, various authorities disagreeing as to whether flint clays change to plastic clays or vice versa, as previously explained. Semiflint clays usually have enough plasticity to make a bond within themselves when worked in the usual commercial manner.

The color of plastic fire clays varies between the 2 extremes of white and black, having such intermediate colors as gray, brown and olive. Flint clays do not show a marked color difference, being either white, gray or mottled black. It is to be remembered, however, that the color of clay is not always to be the guide in its selection for quality, but in some cases it indicates the amount of contained impurities in both the flint and the plastic clays.

IMPURITIES

THE IMPURITIES in fire clays occur in various forms, the iron, for instance, as pyrites, sometimes in large particles widely distributed, and at other times in very small particles uniformly distributed; again, the iron occurs as carbonate of iron, usually in large hard lumps. The lime occurs as gypsum and as limestone. When magnesia occurs, it is usually associated with lime in limestone. The alkalies enter in the form of mica or feldspar.

The amount of contained impurities in the finished product, fire brick, is not always a reliable way of determining the temperature at which the brick will soften.

METHOD OF MANUFACTURE

WHEN FIRE clays are brought from the mine, especially the flint clays, they present a hard rocky appearance, and in order that they can be more readily ground and some of the contained impurities, such as pyrites and gypsum, washed out, they are stored in the open and permitted to weather for a period of several months. The action of the elements causes a disintegration, making the clays softer and easier to grind and more homogeneous, and allowing a great many of the soluble impurities to be carried away. After sufficient weathering each variety of clay is ground in a dry pan and carried into hoppers after passing through the proper mesh of screen, there to be later taken out and mixed in proportions suitable to the class of work in which it is to serve.

The impossibility, on account of excessive shrinkage and consequent liability to warpage, of using all raw clays makes necessary the calcining or burning of some of the clays, preferably the flint clay, to obtain a high-grade product. The amount to be used of this calcined or burned clay is determined by the physical and chemical qualities the manufacturer is striving to obtain for the character of the work he has in hand. As flint clays and calcined clays have no plasticity, a bonding material is necessary, this being supplied by the use of a plastic clay. The amount of plastic clay for bonding varies from 15 to 50 per cent. In some classes of work, practically all plastic clay is used. After the materials are properly proportioned, they are then fed into a mixing machine, where such an amount of water is added as will permit the mass to be worked to the required consistency for molding purposes.

After the bricks are molded they are placed and left on a warm floor until they reach a leather hardness, then pressed by hand to give them better shape and dimension and the manufacturer's brand name. Drying usually requires about 8 hr., but in the case of the highest grade brick this drying is prolonged sometimes for 2 or 3 days, and in the case of large shapes several weeks are required for the proper slower drying through the heavier mass. Unfortunately, in order to meet competition, the manufacturer is compelled to "force dry" some of his bricks, which practice burns or, as we might say, rots the edges, thereby increasing the liability to bad joints after the bricks are placed in the work. When repressed, a second drying occurs, after which the bricks are placed in the kiln for burning at a temperature rang-

*Abstract of paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers.

†With The Chas. Taylor Sons Co., Cincinnati, O.

ing from 2400 to 2800 deg. F. for a period of about 8 days, the first 2 of which are used to drive off with a slow fire principally the contained water, the temperature during these first couple of days not exceeding 900 deg. F. After this the temperature is gradually raised and an excess of air admitted to burn out any carbonaceous material and to convert the ferrous oxide to the ferric state; the ferric oxide is less apt to combine with destructive effects with the silica of the clay. When the bricks are thoroughly oxidized the temperature is then increased to the maximum until all possible shrinkage has taken place.

In burning fire bricks the temperatures are measured by means of electric thermo-couples, radiation pyrometers or optical pyrometers and the degree of heat registered by means of pyrometic cones or other similar heat-measuring devices.

After the bricks are thoroughly burned, the kiln is allowed to cool slowly for about one week when the contents are ready for the market.

Uses of Fire Bricks

Fire bricks are used in innumerable ways, in the various metallurgical furnaces, in the manufacture of lime, cement and glass and in the settings of a very large majority of steam boilers.

With the present modern equipment very much improved combustion occurs, much higher temperatures prevail and higher ratings are obtained than were possible with the less intelligently designed and operated installations and boiler and stoker equipment of former years. Whereas some years previous a 50 per cent overload on a boiler was about the maximum to be expected, it is now not uncommon to see in the larger plants stoker-fired installations operated at 100 to 150 per cent over their commercial rating. Higher overloads do not necessarily mean higher temperatures than could be obtained in boilers operating, say, about rating, but it is more reasonable to expect better combustion and consequently higher temperatures with boilers operating at least slightly above their commercial rating than at or below rating, because of the absence of excess air due to holes more likely to occur in a thinner fuel bed on grates of liberal area.

The installation in a great many plants of apparatus for analyzing flue gases, the establishment of graduated reward systems for good average CO_2 readings and the employment of draft gages, steam recording gages, etc., have prompted the operator to the exercise of greater care and intelligence in firing, which in turn has resulted in better combustion, consequently higher initial temperatures and harder service on brick setting work.

It would seem from present-day experiences that the capacity of most stoker-fired boilers is limited only by the ability of the fire bricks to withstand the extreme temperatures generated. As an example of high temperatures we might cite a case, which is brought to our attention, of an efficiency test in some stoker-fired furnaces where a quantity of platinum was melted in a graphite crucible, the melting point of platinum being 3191 deg. F. This temperature approaches very closely to the melting point of pure fire clay, which is 3326 deg. F.

Refractories with High Melting Points

Efforts have been made to substitute materials with higher melting points than the commercial fire clay brick, but due to the inability of these materials to withstand certain other conditions, such as sudden heating and cooling, pressure at high temperatures, the action of certain gases of combustion, and the chemical action of certain fused ash, these substitutions have failed to realize the theoretical expectations and were disappointments. The other refractories which have been given a trial in boiler work are silica, bauxite, chrome and magnesite.

Selection and Use of Materials

A great deal of trouble with fire brick settings is due to the improper selection and ignorance in the use of the materials, and also in many cases to the lack of care in constructing and laying up the work. In arches, particularly where the service is hard, care should be taken that all brick in the same row are of the same thickness and shape, as it is difficult to secure high-grade brick of exactly the same thickness and uniformity.

A conscientious mason will carefully select his brick, culling out those of very irregular shape, and will try the selected brick dry over the arch form with a straight edge. Then he dips them in a creamy solution of fire clay and rubs them in place. Bricks of uneven thickness should be cut and rubbed. If this care is not exercised large fire clay joints will be had and the life of the arch seriously affected.

Wedges should be used as often as is necessary to keep the bottoms of the bricks in even contact with the arch form, and the key brick course should make a true fit from top to bottom. The key brick should be driven from one to about 1½ in., depending upon the hardness of the brick and the width of the arch.

Fire Clay Mortar and Its Relation to the Life of Fire Brick

All fire brick, whether fire clay or special refractories, should be laid in mortar of nearly the same composition as the brick itself to prevent a fluxing action, such as would be caused if, for instance, silicious mortar was used with magnesite brick. In the case of fire clay bricks, a very good grade of fire clay should be used, the refractoriness of which is practically equal to that of the bricks themselves.

In mixing fire clay to be used as a mortar, best results can be obtained by using a certain amount of fire sand, i.e., pulverized calcined clay or bricks. This prevents shrinkage of the raw clay and the crumbling out of the joints. Some boil the clay, feeling that it takes out the shrinkage, although there is not enough heat in the boiling process to take out any appreciable shrinkage; but this method results in a very complete mixture, making it free from lumps and putting it in shape to make a good, tight, first-class job of brickwork.

Laboratory Tests on Fire Brick Compared with Practical Tests

In selecting bricks to be used in furnace practice, the manufacturer is often asked for an analysis of the kind of brick he intends to furnish in order that the user may judge as to the quality of the brick. The

analysis alone of a brick does not afford the best way to judge its suitability for the work intended, as the analysis merely shows the composition of the brick without giving any information as to its physical properties, which are usually more important than the chemical composition. The analysis does not reveal the way in which the impurities occur, a very important item in considering the temperature to which the bricks may be subjected without danger of failure.

To secure a sample for determining in a laboratory the melting point of a fire brick, the usual method is to knock a corner, about 1 in. high, off a brick, the bottom of the test piece so secured forming a triangle, each side of which measures approximately ½ in. This piece, together with 3 small cones, each having a different known melting point, is then placed in an electric furnace for observation as the temperature of the furnace increases. When the sample piece of fire brick, in the form of a small pyramid, loses its shape, it is considered melted, and the highest pyrometric cone which is melted alongside of the test piece indicates the melting point of the brick.

This way of determining the melting point has the advantage over other methods using pyrometers, inasmuch as these cones take into account the time element; time should be considered in determining the softening temperature of any fire clay product, as a brick which melts at a very high temperature, say in one day, can be melted at a much lower temperature by holding the heat for a longer period of time.

The melting point is sometimes determined by means of an optical pyrometer, which is also a good method, if all tests are carried out in the same length of time, so as to be comparative.

The service, due to heat alone, is not as severe on fire bricks placed in walls which are exposed to the atmosphere as in partition or division walls between furnaces where the heat is acting on both sides of the wall. That this is true is demonstrated by the longer life that arches exposed to the air on one side will show over arches which are subjected to fire on both sides. Although brick work will show longer life where there is such cooling action, this gain is usually made at the expense of lost heat energy.

United States Government Tests

Another way to determine the softening point is by means of the government load test. This test consists in placing a brick on end, loaded 50 lb. per sq. in. of cross section, and in having it successfully stand a temperature of 2400 deg. F. for 1 hr. without showing any deformation, checking, spawling or contraction greater than ½ in. in length. In making this test the heat is brought up so that 2400 deg. F. is reached in 4 hr., when this temperature is maintained for another hour.

Another government test consists of breaking up a brick and subjecting the pieces to a temperature of 3200 deg. F., which they must stand without softening. Under the load test, if the brick contains many impurities, its fluxing action will take place at this temperature or at a lower temperature and cause the brick to soften, thereby allowing it to compress under the total weight of about 562 lb. This load test is really better than the melting or softening point test, as it shows more clearly the temperature at which the brick commences to soften, and this is the temperature which the user of fire brick, especially fire brick for boiler practice, is interested in.

It is also a better comparative test than the melting point test, as the time element is always the same, and it is merely a case to determine the condition; whereas in the melting point determination the question always arises at just what point the brick is considered melted, that is, whether it is melted when the tip and sharp corners of the pyramid become rounded or whether it is melted when the piece of brick is seen distinctly to flow, the difference in temperature between the 2 points being considerable, as the viscosity of most brick is very high.

Conductivity

The conductivity of fire brick is a property seldom mentioned in considering brick for boiler practice, but in this connection it might be stated that tests have shown that a hard burned, dense brick possesses a higher conductivity than a soft, open grain brick. The chemical analysis does not provide information as to the rate at which a fire clay brick will conduct heat, this property depending entirely upon the physical make-up of the brick.

Some Causes of Failures

A not infrequent cause of trouble in arches is spawling, which is a popping-off of large pieces of the bricks. This spawling sometimes results from arch bricks becoming frozen or wet through a leaky boiler tube, header cap, drum seam or water used in washing out or in turbining the boiler tube. With this condition unnoticed or unknown to operators, a hot fire is started before the bricks have been slowly dried out, with the result that some, if not all, of the brick crack and pop off. Once this action is started in any part, the balance of the arch is usually doomed to early destruction. This for the reason that the adjoining bricks are exposed with more than one side to the action of hot gases, more area is receiving heat and more heat is being absorbed by these bricks than they have capacity to take care of by conduction through their own body and by final radiation to the atmosphere or a cooler zone of the furnace.

Spawling again may be caused by the natural inability of the brick to withstand the very high temperatures of large volumes of slowly moving or confined gases of combustion. The ends of the brick are absorbing heat faster than they can deduct it to a comparatively cooler zone, consequently the clay in the exposed ends becomes vitrified, the elasticity of that portion of the brick is lost and when further heating and cooling takes place, the difference in the rate of expansion and contraction between the 2 parts of the brick causes a separation, the vitrified section dropping off unless held temporarily by the compression of the arch.

Spawling is also the result of strains due to in-rushes of comparatively cold air striking the incandescent bricks and suddenly contracting them. These cold blasts occur when fire doors are held open too long, or when hand or stoker-fired grates are improperly operated and large holes in the fuel bed permit a strong draft to pull the cooler outside air into the very hot furnace.

Another trouble with arches is caused by the improper setting of the skewbacks, through failure to pack

them up tight against the buckstays at the sides of the furnace, or using with them as filling-out pieces, fire brick which come up tight to buckstays and are set snugly together without fire clay joints.

Allowance for Expansion and Contraction

Arches should also be designed and constructed so that they will meet no interference when expanding or contracting. They should not be tied into any front wall brickwork or carry the weight of any other part of the setting. One also should strive to secure as nearly as possible the same conditions both under and above the arch for its entire length. In other words, if an arch within a boiler setting is made a continuation of the dutch-oven arch outside the boiler setting, there is a liability of the arch breaking. The extension furnace arch has its upper side exposed to the cooler atmosphere, while the inner arch is in contact with the hot gases of combustion on both sides. The rate of expansion of these 2 differently located parts of the arch, it is evident, will be different.

Spring of Arch

Arches also with too much spring frequently buckle and break their backs when they rise by expansion. A rise of spring of 2 in. to the foot of furnace width is the commonly adopted practice. This gives a reasonable spring to the flatter arch and acts as a resistance to expansion, keeping the arch tight.

Rounding off the last or end bricks in an arch frequently lessens or remedies the trouble caused by these ends sometimes spawling off, due to the gases making a short, right angle turn and throwing an intense heat into the corner of these bricks which have 2 of the faces exposed.

In considering fire bricks for different parts of a furnace, it must be borne in mind that the conditions in side walls are different from those in an arch and that a brick which often gives excellent service in arch practice does not always give correspondingly fine results in the side walls of the same furnace. It is, therefore, policy in some cases to use 2 kinds of brick rather than to try to make one brand do for both places.

Arch practice requires a brand of fire brick that is not only sufficiently refractory to withstand high temperatures, but one that will withstand these temperatures under much compression, will not spawl and has a minimum amount of shrinkage and expansion.

In the United States Government tests made on various bricks throughout the country, many brick were found which would hold up under a temperature test alone of 3000 and 3200 deg. F. without softening, but only a few, we understand, stood the heat test under pressure.

Furnace side walls are not affected so much by spawling, but are frequently affected through the chemical action of the fused ash and distilled gases of some coals. Generally speaking, where coal is used as fuel, furnace side walls require a brick less porous and soft than would be used in an arch, in order to stand abrasion, due to the fire tools and cutting action of the clinkers when being disturbed or removed.

Arch Blocks

Blocks for arches and side walls are sometimes used, and give, in many cases, better results than standard 9-in. brick. They have the advantage of reducing the number of joints and parts to lay, and the radial arch blocks turn true to the given circle. These arch blocks are always made on special orders of a special combination of clays, are tried for fit, and by some manufacturers machined down, where necessary, on a carborundum wheel to secure level sides and to insure a good fit on the job. On account of the greater mass of contained material, these blocks must be carefully and slowly dried on a cool floor and carefully burned.

Perfect combustion means very high temperatures and better furnace efficiencies, but shorter life to the brick work. Therefore, what to some of us appears to be costly brick work maintenance charges in some plants, has been determined by these operators, especially in the large public service plants, as reasonable, considering the excellent furnace efficiencies. It is a question often as to which is cheaper, to use more coal and buy less brick per unit output, or to use less coal and buy more brick.

American Mining Congress is to meet in the Auditorium at the Panama-Pacific Exposition, Sept. 20 to 22. There will be present representatives from states and territories, and cities and towns throughout the country, boards of trade, mining bureaus, scientific societies and engineers' associations. The subjects which will be taken up will cover mining and mining investments, the question of public lands, and the utilization of mineral resources on these lands, metallurgical research and mine safety, co-operation in coal mining, and the export of coal, and the conservation of our coal resources by utilizing the available undeveloped water power on public lands.

The mining interests of the nation, considered from the national standpoint, have not had the attention which they deserve, and which their importance in the field of industry warrants. The result has been a decrease in mining activity, which is in part responsible for the business conditions now prevailing. The 2 primary industries, Mining and Agriculture, are not at the present time employing their proper proportionate share of the workers of the country, and until this disproportion is remedied, the pressure of industrial conditions in manufacturing and transportation industries is likely to be maintained. Any effort which looks toward the increasing of the number employed in mining and agricultural pursuits is, therefore, a step in the direction of relieving the entire industrial situation, and is worthy the careful attention of all interested in the welfare of the country.

In a plant using coal costing $1.48 a ton in the bunkers, the evaporation from and at 212 deg. per lb. of coal was found to average for the 3 mo., Dec.,-Feb., 6.42 lb. Coal cost per 1000 lb. steam was 13.65 cents, boiler room labor 1.355 cents, repairs and maintenance for boilers and furnaces 1.118 cents. In a second plant, with coal at $1.65 a ton on track, the costs ran per 1000 lb. steam, coal 14.35 cents, labor 1.215 cents, repairs and maintenance 0.571 cents and evaporation from and at 212 deg. 6.65 lb.

Over Land and Sea with a 16-Ton Boiler

DIFFICULTIES EXPERIENCED AND OVERCOME; PROPER METHOD OF RIVETING STACKS. BY H. K. SCHOLEFELD

IN A LATE issue, Tom Jones tells how he handled a boiler, which recalls work done by myself. As our plant is situated on an island, all freight is delivered by steamboats and with insufficient depth of water for dockage, it is necessary to transfer the freight by means of whaleboats and small lighters, which are brought up to a landing place and discharged.

When boilers are shipped, no lighters are to be had which will carry them; they are therefore hoisted overboard by the steamers and floated ashore, the manholes being first closed and all tubes plugged with redwood stoppers, driven in each end.

Our plant is situated 3 mi. from the landing place and 800 ft. above sea level, with a narrow road winding up the hill, over which everything must be hauled by wagons. Furthermore, this road did not, until recently, have a branch leading to our mill, so that it was necessary to transfer all freight onto flatcars of an industrial

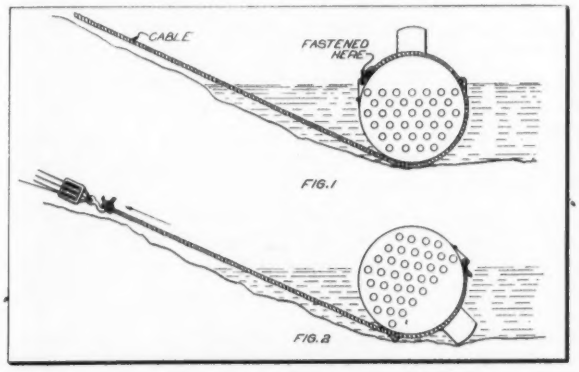


FIG. 1. FIRST STEP EMPLOYED IN LANDING BOILERS
FIG. 2. POSITION ASSUMED BY BOILER AFTER TAKING UP ON CABLE

railroad crossing the wagon road and connecting with the mill. The problem of hauling 16-ton boilers out of the sea, up the hill on a truck and reloading them onto a flatcar is something worth considering.

The boilers in question were 7 by 20-ft. units, weighing 14 and 16 tons, respectively, each with a dome on top. To get such a boiler out of the sea, we towed it to a spot where a sandy beach slopes down to and under the water. We tried to find deep sand, but the best place was only 12 in. deep, rock being underneath. The boiler was brought up parallel with the shoreline and 2 wire cables passed under it. These were bent up and made fast to the hangers on the land side, Fig. 1, one cable leading to each end of the boiler. When the cables were drawn up as tight as we could haul them, pulling alternately on each one, the boiler assumed the position shown in Fig. 2.

When the boiler had been raised slightly above its floating depth, and was hard aground, it could no longer be dragged, so we laid our tackle the opposite way and rolled the boiler as in Fig. 3. This also shows the manner of setting the anchor, hand winch and rope blocks. The fact that hard rock lay under the sand made it necessary to use the cribbing A in order that the dome might clear the rock, otherwise I could have dug a hole in the sand every time the dome came over. The cribbing caused us no end of trouble, as the waves would float it off as fast as we set it up; however, when

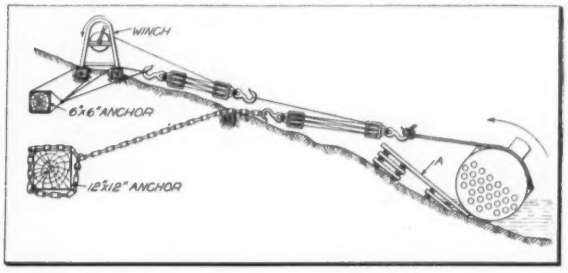


FIG. 3. CABLE NOW FASTENED TO OPPOSITE LUG AND BOILER DRAWN UP ONTO CRIBBING A

the weight of the boiler once rested on it, it stood still. Figure 4 shows how the truck was placed so that when the boiler reached it, the dome would be in the proper position, for reasons to appear later. One wheel was removed and the truck bed blocked. The boiler when loaded rested in the cradle A.

To haul the truck up the 3 mi. of road, 24 California mules pulled in 6 spans of 4 each. Expert teamsters were required, as it took great skill to make such a long team pull properly when rounding the curves in the road. The leaders, being out of line with the wagon-pole, tended to pull the truck into the ditch.

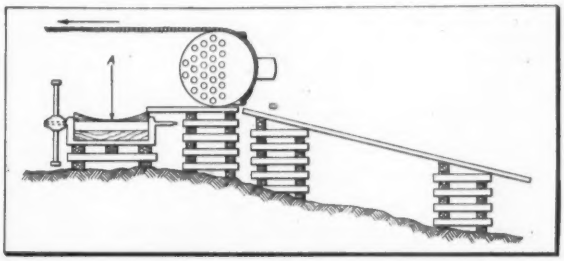


FIG. 4. TRUCK IN POSITION TO RECEIVE BOILER WITH DOME UP

Figure 5 shows how we removed the boiler from the truck to a flatcar; we again removed a wheel and blocked the truck, but this time used a locomotive for the pulling power, as shown in plan. The plan shows the car and truck properly placed without the boiler. The value of having the boiler so loaded on the truck that, when unloaded, the dome will be uppermost is now apparent. Once on a car, the boiler was soon hauled to the mill.

Figure 6 shows screw jacks with a large female center in the screw head. These we used when shifting the boiler about, as they fitted the conical rivet heads, mak-

ing it impossible for the jack to slip. The seams of a boiler are the most rigid parts to jack under.

Tom Jones asks which of 2 ways is better when riveting a stack, Fig. 6 or 7, on page 181 of the Feb. 1 issue. With a brick lining to protect the stack inside, Fig. 7 is better, as the joints cannot pick up rainwater. Without a lining, Fig. 6 is proper, as the upper part of the joint can be fairly well sealed with paint outside. This cannot be done if it is made as in Fig. 8.

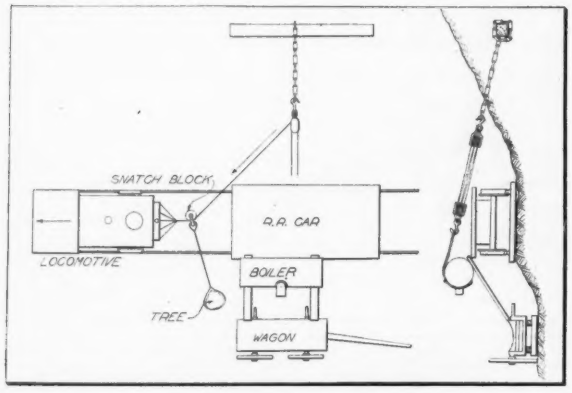


FIG. 5. PLAN AND ELEVATION OF SCHEME EMPLOYED TO TRANSFER BOILER FROM TRUCK TO FLAT CAR

Here is a quick way to find the length of guy wires for a guyed steel stack. Knowing the distance from the ground to the upper eyebolt to be 50 ft. and from stake B to base of stack 80 ft., I measure and make a mark, A, Fig. 7, 50 in. high above the floor, on the wall. Make another 80 in. from the wall, on the floor, calling it B. Then measuring direct from A to B, I get 94⅜ in., which I call feet and cut my guys accordingly. Thus I avoid having to hunt up the way to extract square roots, a process which I cannot remember over night.

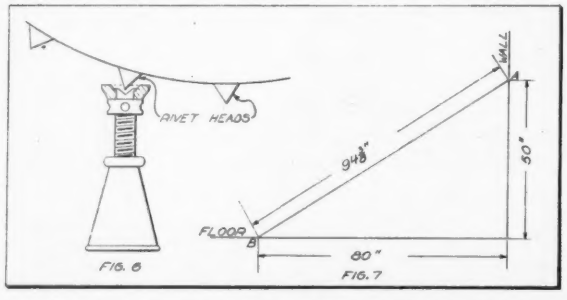


FIG. 6. USE OF DISHED SCREW JACK HEADS PREVENTED SLIPPAGE

FIG. 7. METHOD OF FINDING PROPER LENGTH OF GUYS

To get a close estimate of the height of a standing chimney, find the length of its shadow on level ground and compare this figure with the length of the shadow of a 10-ft. pole. The problem is one of simple proportion. If a 10-ft. pole casts a 5-ft. shadow and the stack casts a 50-ft. shadow, then 5 is to 10 as 50 is to X. X, therefore, is equal to the product of 10 times 50 divided by 5, or 100 ft.

Centrifugal Pump Notes

REPLYING to inquiries as to data on centrifugal pumps, the Power User gives the following:

Speed in feet per minute at the outside of the runner or impeller should be equal to the velocity of water falling from a height equal to the head pumped against, including allowance for frictional resistance in piping, valves and pumps, and also suction head, if any.

Illustrating by figures, take the case of a pump for 500 gal. per min. at 120 ft. head, with runner 13.5 in. diameter; suction inlet 7 in. diameter; outlet 5 in. diameter; driving pulley 9 in. diameter. The 120 ft. is total head, and working head would be less by that used up in friction, which depends on the length and character of suction and delivery piping.

Velocity due to the head will be,

$$v = \sqrt{64.4 \times 120} = 87.9 \text{ ft. per sec.}$$

or $87.9 \times 60 = 5265$ ft. per min.

and the velocity of the impeller at the outside will be,

$v_1 = 3.14 \times (13.5 \div 12) \times \text{r.p.m.} = 3.65 \times \text{r.p.m.}$ which must equal 5265.

Hence, the r. p. m. $= 5265 \div 3.65 = 1445$.

If it is desired to use this pump for a lower pressure, say 100 ft. head, the speed would be reduced in proportion to the square root of the head, or

$$\text{r. p. m.} = 1445 \div \sqrt{120} \times \sqrt{100} = 1320$$

otherwise the extra pressure would result in increased flow unless the friction through the valves was increased by throttling, which would result in large waste of power, or, if the volume pumped increased, a possible overload on the driver.

To illustrate this point of overload, an economical rate of flow would be 9 ft. per sec., or 108 in. per sec., through a 5-in. delivery main, and the amount pumped would be $108 \times 19.64 \div 231 = 9.18$ gal. per sec. or 551 gal. per min.

If the length of suction and delivery pipe is 150 ft. and the foot valve and bends may each be taken as the equivalent of 10 ft. additional, the total equivalent length causing friction would be 170 ft., which at 9 ft. per sec. velocity would give by Darcy's tables 5.56 ft. friction head or a total of 105.56 ft. to overcome. The power required would then be, $551 \times 8.33 \times 105.56 \div 33{,}000 = 14.6$ hp.

If 6-in. delivery pipe be used, the velocity and friction head remaining the same, the volume pumped would be, $108 \times 28.27 \div 231 = 13.22$ gal. per sec., or 794 gal. per min., and the power required would be, $794 \times 8.33 \times 105.56 \div 33{,}000 = 21.2$ hp.

This would be slightly high, since the friction head in 6-in. pipe would be somewhat less than in 5-in., but this would be partly offset by increased friction in the pump passages due to overload.

It is thus seen that slight changes from the specified arrangement may result in large changes in operating conditions, and slight increase in speed may result in heavy overload on the driver due to the greatly increased capacity.

COST OF 1000 lb. of steam is estimated by the Station Operating Committee of the N. D. H. A. as 20 cents in the most favored plants, possibly $1 in extremely high cases and 30 cents as a general average.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Testing Polyphase Watthour Meters

METHOD OF CHECKING WHICH AVOIDS DISCONNECTING INSTRUMENTS FROM TRANSFORMERS. BY F. R. INNES

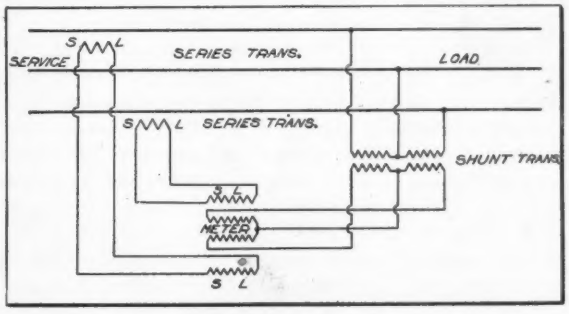
DETERMINATION of the correctness of the connections of a polyphase watt-hour meter while the meter is in use is sometimes extremely difficult. In case the meter is connected through instrument transformers to a high-tension circuit, the operation is dangerous. When the power-factor of the load is known at least approximately, the correctness of the connections may be determined by comparing the reading of the watt-hour meter with the readings of the voltmeter and ammeter. However, when the power-factor is not known, the most satisfactory check of the connections of a polyphase meter is to identify each lead as coming from a definite secondary terminal on the series or shunt instrument transformer and going into its proper meter terminal; that is, a check which will furnish the same information as actually disconnecting, ringing out and tagging the secondary wiring.

Such a method of checking, which avoids disconnecting the wiring between the transformer secondaries and the meter, consists in paralleling each secondary lead with a test lead and utilizing the current produced in this test of parallelism. The accompanying illustration, which shows the proper connections for a polyphase watt-hour meter, will make clear the basis of this method.

The identification of the leads between the meter and the shunt instrument transformer secondaries is effected by connecting a lamp of the proper voltage in series with the test lead and one potential terminal of the meter, and by touching the free end of the test lead successively to each secondary potential terminal. The terminal at which the lamp remains "dead" is connected to that meter terminal to which the lamp is connected. Each secondary terminal is identified in like manner.

When 2 independent leads are brought from each of the 2 series transformers they may be identified as follows: First remove all known interconnections, such as grounds, etc. If the installation under check is a high-tension one, all of the precautions incident to the handling of underground secondaries should be observed. Use should be made of a test lead having a resistance less than that of the secondary of the series transformers, no lamp, of course, being used in this case. The end of this test lead should be connected to one meter terminal and the free end of the lead should be touched successively to each secondary terminal of the series transformers, note being made of the sparks. On one transformer a slight static discharge will probably be observed at each terminal, on the other a current discharge through the short-circuit formed by the test lead will be seen at one terminal, and at the last terminal there will be no spark. This "dead" terminal is then the one connected to that meter terminal to which the test lead is attached. The same procedure is to be followed in the identification of each secondary lead.

A current discharge at one terminal on each transformer indicates a connection between the secondary coils; this connection should be removed, or, if that is difficult, the procedure described below for the 3-wire, or common-return, secondaries should be followed. If 2 of the secondary terminals remain absolutely dead and a heavy flaming discharge is seen at the other 2, the 2 secondaries are connected in series through the 2 series elements of the meter. Such a connection is, of course, wrong and should be rectified.



CONNECTIONS FOR TESTING WATTHOUR METER

When the 3-wire or the common-return system is used for the series transformer secondaries, the same procedure should be followed, the test lead being connected to one meter terminal and the free end touched successively to the secondary terminals of the series transformers. If the connections between the meter and the transformers have been properly made, a current discharge will be noted at 2 of the transformer terminals. To ascertain to which series transformer the meter element connected to the test lead is connected, short-circuit one transformer at the secondary terminals and touch the end of the test lead to the terminals of the other. If a spark is observed, the second transformer is connected to the meter element under check, and the identity of the lead under check is determined by noting which transformer terminal re-

mains "dead." If no spark is observed at either terminal, the short-circuit should be moved to the second transformer and the test repeated. If a spark is seen at each transformer while the other is short-circuited, the test lead is connected at the meter to the common return.

It may happen, in the event of the installation under check being without load or operating at extremely light load, that the sparks at the series transformer may not be perceptible or may be indistinguishable from static discharges. In this case the voltage of the secondary may be increased by the introduction of reactance into the secondary circuit. The writer has not found this expedient necessary, however, in his use of the method.

After the connection of each lead has been checked in the manner prescribed and properly identified as belonging to a particular secondary terminal on the series or shunt instrument transformer the proper connections at the meter can readily be made.

In checking the leads as above described, it must be remembered that an ungrounded instrument-transformer secondary should be handled with the same caution as would be accorded to the line primary circuit. It is also well to keep in mind that a closed series transformer secondary is comparatively innocuous, but an open one must be treated with respect.—Electrical World.

Splicing Conductors

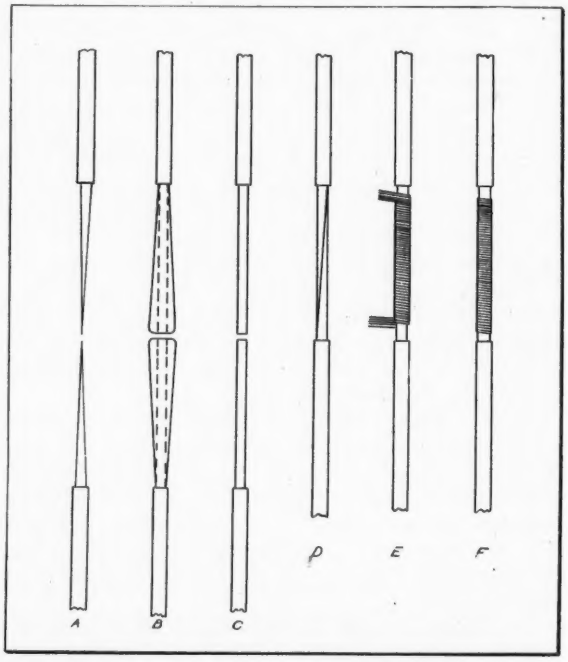
ARMATURE winders and repair men are many times called upon to make repairs which would ordinarily tax the ingenuity of the average man. One such piece of work is that of splicing broken or burned off armature leads and conductors.

In almost all types of electrical machinery and apparatus, every bit of available winding space is utilized. As an example, the slot in the armature of a direct-current motor or generator is generally of such dimensions that few if any more conductors can be crowded into the space allotted them, so that when it becomes necessary to make repairs on any of the windings or their connections, it is of importance that the work be done in such a manner that after being disturbed, all conductors can be returned to their original places.

Many times, due to a weak spot in the insulation, lightning will jump from an armature conductor to ground through the armature core, and one or several conductors will melt, necessitating the splicing of their ends before the machine can be used. One way to make such repairs is as outlined in the following paragraphs.

After the bands and the upper layer of insulating material, which generally consists of strips of wood or fiber are removed, the conductors in the slot containing the damaged member are carefully raised a trifle above the surface of the core, until the open ends are reached, which are then carefully drawn out as far as may safely be done. A block of iron or steel having a perfectly smooth surface is held against one of these ends, so that this may be flattened with an iron hammer into a wedge shape, as shown at A and B in the accompanying figure. The lower conductor shown in these figures is the short length of wire, used as a splice between the 2 damaged ends. By means of a pair of tin shears the surplus material is cut off along the dotted lines as in B, after which the edges are filed smooth with a fine file and the entire surfaces cleaned with fine sharp sandpaper. The 2 ends to be joined are as shown at C, the width of which should be a trifle less than the diameter of the wire. These ends are then well tinned with solder, and while still hot are joined as shown at D. While a joint of this sort might hold electrically, it would be entirely too weak to withstand any mechanical stresses and it is, therefore, necessary to strengthen it.

Four or 5 small-gage conductors such as found in ordinary flexible lamp cord are cleaned and polished with fine sharp sandpaper and carefully and smoothly wrapped around the joint as at E. The whole joint is then heated with a soldering iron held against it and



VARIOUS STEPS IN SPLICING AN ARMATURE CONDUCTOR

solder and finely powdered rosin are allowed to run into and between the fine wires and the joint, thus producing one solid mass. The ends of the wrapping wires are then clipped and the whole joint filed down with a smooth finish to a diameter equal to that of the original conductor. It is then gone over with sandpaper, wrapped with linen tape and the whole well shellaced.

The opposite end of the splice and the other end of the damaged conductor are then treated in the same way; but in joining these, it is necessary that the work be done as near the surface of the core as possible, so that the spliced conductor may readily be driven into place without a bulge on account of any excess length.

THE UNITED STATES Government uses the following mixture for cleaning brass: Common nitric acid 1, sulphuric acid, ½. Dip articles into acid, remove to water, finally rub with sawdust. If brass is greasy, first dip into strong solution of potash and soda in warm water.

Theory of Commutation*

USE OF COMMUTATING POLES AND HIGH RESISTANCE BRUSHES AN AID TO PROPER COMMUTATION

A DIRECT-current armature, when carrying current, becomes a true electro-magnet, with the poles located on the armature at positions corresponding to those coils which are in contact with the brushes. If the armature were surrounded by a smooth ring of iron, as shown in Fig. 1, a magnetic field would be set up between the armature and the surrounding ring, this field having maximum values at points corresponding to the brush contacts and zero values midway between. The magnetic field would rise, from the zero points, uniformly to the highest values, because the armature winding, which is a magnetizing winding, is uniformly distributed over the armature core. If, now, deep notches were cut in the surrounding ring at points corresponding to the highest field, Fig. 2, there would be a comparatively weak field at these points, due to the high reluctance of the gap or notch. The external ring in this case represents the field structure of an ordinary direct-current machine, and, in such machines, the armature when carrying current actually tends to set up magnetic fields in this manner, and the coils in contact with the brushes are practically always located in the space between poles,—that is, in the notches in the surrounding ring in the above illustration. Also, the coils in contact with the brushes are those in which the current is reversed in direction when passing under the brushes, or, in other words, are the commutated coils. It may, therefore, be seen that the commutated coils always lie in what should be the strongest magnetic field set up by the armature winding, if there were no polar notches. But, even with such notches or interpolar spaces, the armature winding, when carrying load, tends to set up some magnetic field, part of which is in the space over the armature, and part of it across the armature slots. This latter flux from slot to slot, is not influenced by the notches in the surrounding iron, —that is, by the interpolar spaces. In addition, the armature winding sets up a magnetic field around the end windings.

The armature winding, when carrying current, therefore, always tends to set up a magnetic field, through which the armature conductors rotate and generate electromotive forces just as when they cut the main field set up by the field windings. These coils short-circuited by the brushes also generate electromotive forces, and as their terminals, which are commutator bars, are connected together or short-circuited by the brushes, on the commutator, the electromotive forces generated by cutting the armature flux tend to cause local or short-circuit currents to flow in such coils. Such currents will be known hereafter as the local or short-circuit currents, to distinguish them from the useful or work currents of the armature.

As an armature coil carrying current in a given direction, approaches and passes under the brush, the current should die down to zero value at the midpoint of the brush and should rise to full value in the opposite direction by the time the coil leaves the brush. This would be a theoretically perfect condition, but is difficult or almost impossible to attain in practice. The coil, while under the brush, has an electromotive force generated in it due to cutting the armature field, as already described, and a local current circulates. This short-circuit current normally adds to that of the work current before reversal, and thus tends to maintain it right up to the moment that the coil passes out from under the brush. The reversal of the current in the short-circuited coil is thus accomplished almost instantaneously instead of gradually. If, however, this local current could be generated in the opposite direction, it would tend to oppose the work current as the coil came under the brush, so that the resultant current would first die to zero and then rise in the opposite direction, if the short-circuit current were just large enough; so that the work current would simply replace

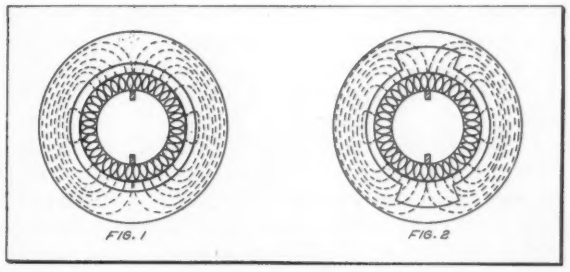


FIG. 1. MAGNETIC FIELD HAVING MAXIMUM VALUE AT POINTS CORRESPONDING TO BRUSH CONTACTS AND ZERO VALUES MIDWAY BETWEEN

FIG. 2. NOTCHES CUT IN RING AT POINTS CORRESPONDING TO HIGHEST FIELDS; RELUCTANCE OF GAP RESULTS IN COMPARATIVELY WEAK FIELD

the short-circuit current in direction and value as the coil passes out from under the brush. If, therefore, the short-circuit current were of exactly the right value, the resultant effect would be the same as if the work current alone were present and this current died down to zero value as the coil passed the middle of the brush, and rose to full value in the opposite direction by the time the coil left the brush. In other words, a local current of the proper direction and value in the commutated coils will give theoretically ideal commutation. Such local current therefore, might be designated as the commutating current. In practice it is found that a current somewhat higher than the ideal value gives the best general results. In any case, however, this local current, to be effective, must be in the reverse direction to that which would normally be set up by the armature coil cutting the magnetic field due to the armature winding itself. This means therefore, that where commutation is accomplished by means of short-circuit or local currents, an external field in the opposite direction to the armature field is necessary for setting up such local

*From a paper read by B. G. Lamme before the Association of Iron and Steel Electrical Engineers.

currents. This result may be accomplished in several ways. The brush may be rocked forward or backward until the commutated coil comes under the magnetic field, or fringe of the field, set up by the main field winding. If rocked in one direction (forward in the generator, backward in the motor), the direction of the main field will be in opposition to the armature field. Obviously, if shifted into a strong enough external field, the armature field may be completely neutralized at some given point, such as that of the short-circuited coil, or the resultant field might be even strong enough in the opposite direction to set up the desired local or short-circuit current in the commutated coil. Under this condition, ideal commutating conditions should be obtained. However, as the armature magnetic field at this point tends to vary with the armature current, while the external field tends to remain constant, it is evident that the ideal resultant field will only obtain at one particular load. Only an average condition can, therefore, be obtained in this way. However, by shifting the brushes backward or forward under the external field, the proper local or commutating currents should be obtained for any given load; but brush shifting is not usually considered a practical method of operation, although required by many noncommutating pole machines in service. What is needed is an external field directly over the commutated coils which is always of the proper strength to set up commutating currents of the right direction and of the proper value with respect to the work currents, so that the resultant in the short-circuited coil will give the effect of the work current reversing at the middle of the brush at all loads. To accomplish this, an external field to produce this local current should always be in opposition to the armature magnetic field, should be somewhat greater in value, and should vary in proportion to the armature field,—that is, to the armature current. This result is accomplished by the now well-known commutating pole, which is simply a small pole placed over the commutated coil, and usually excited by a winding directly in series with the armature, but having a somewhat greater magnetizing force than the armature winding. The function of this pole is solely to set up in the armature coil a local or commutating current of the proper direction and value.

A condition which makes the problem of commutation much easier to solve is the use of a relatively high resistance in the short-circuited path of the coil which is being commutated. Due to the extremely low resistance of the ordinary armature coil, a relatively low magnetic field set up by the armature would generate enormous local currents in the short-circuited coil if the resistance of the coil itself were the only limit. These currents might be 10 to 20 times as great as the normal work current, and would add seriously to the difficulties of commutation. Even if a commutating field were present, this would have to be proportioned and adjusted so accurately, to get the right value of the commutating current, that the construction would be almost impracticable. But if considerable resistance, compared with the coil itself, could be interposed in the short-circuited path, this obviously would so greatly assist in fixing the value of the short-circuit current that undue refinement and adjustment would not be necessitated. Now, if, instead of the zero resistance brush contact, one of about 10 times the resistance of the coil is used, then the total resistance in circuit becomes over 10 times as great, and the short-circuit current is cut down to a value comparable with that of the work current. Therefore, a relatively high resistance brush—that is, one with contact resistance high compared with the resistance of the coil—is of material aid in commutation. This is wherein the carbon brush is such a successful, or even necessary adjunct of the commutating machine.

The principal function of the carbon brush being that of limiting the local current, it might be assumed that the advantages might be increased indefinitely by further increasing the resistance, but there are usually limits to all good things. The carbon brush increases the resistance in the path of the local currents, but it also increases it in the path of the work current. If the resistance is carried too high, the losses due to the work current may constitute a more serious objection than the local currents. Consequently, practice is one continual compromise on this point. In those cases where the short-circuit current is normally relatively small due to low value of the armature magnetic field, it is obvious that a lower resistance in the short-circuit path can be used, or, in other words, a low-resistance carbon brush is practicable, with consequent low loss due to work current. In other cases with higher inherent local current, higher resistance carbon will give better average results. It is thus obvious that one grade of carbon brush is not the best one for different machines unless they all have similar inherent commutating conditions. It is exceedingly difficult to give equal commutating characteristics to machines of different sizes and types, and, in most cases, even of the same type or line. In noncommutating pole machines, the grade of the brush is of more importance than in the commutating pole type, for in the latter, we have a means, in the commutating pole strength itself, of modifying or controlling the value of the local current. But the best commutating pole gives only average correction,—that is, average value of the desired local current, and the resistance of the brush must be depended upon to take care of pulsations or irregularities in the local current, acting to smooth them out to a greater or less extent. Thus a fairly high resistance brush is required on the commutating pole machine, but its resistance usually can be lower than that required in the noncommutating pole type.

AS AN INDICATION of what may be accomplished by using brains in operating a plant, 3 tests were conducted by a committee of the National District Heating Association on a 500-hp. boiler. The first was with operation as it existed and showed 5.85 lb. actual evaporation per pound of coal. More careful operation was then tried, and a second test showed 6.88 lb. evaporation with an efficiency of 64.2 per cent for furnace and boiler at a load of 130.9 per cent of rating. A maximum capacity test gave 138 per cent of rating. Changes in the setting were then made costing $250 per boiler or 50 cents per horsepower, but without changing grate or heating surface, and 210 per cent of rating was obtained on the average with maximum for an hour of 300 per cent.

Foundation Anchor Bolts for Engines and Machinery

FUNCTION, TYPES AND DESIGN OF ANCHOR BOLTS; CONSIDERATIONS WHEN PURCHASING MACHINERY. BY TERRELL CROFT

IF, when a man desires to lay out a machinery foundation, he seeks data or references relative to foundation design he will find little or no data that will be of assistance. For some reason or other, the subject of machinery foundation design has been almost wholly disregarded by the various works on mechanical engineering. It has apparently been the practice for each man who designed a foundation to work out his own salvation, and whether the foundation was poorly or well designed depended almost wholly on the experience of the designer. The experiences of other designers along similar lines have not been disseminated to any material extent. The writer has devoted much time and thought during the past 6 or 7 yr. to this subject, and has retained and classified all of the information concerning it that has evolved from his own experience or been obtained from the experience of others. It is the intention to summarize this information insofar as it relates to anchor bolts in the article which follows.

WHY USE BOLTS?

THE FUNCTIONS of anchor bolts for machinery foundations are 2: The first duty of the bolt is to hold the machine down firmly on the foundation or mass of masonry on which the machine rests or is supported. The second function of anchor bolts is to prevent the machine from sliding laterally on its foundation.

It is apparent, then, that every anchor bolt is, theoretically at least, subjected to a tensile stress due to the clamping of the machine to the foundation, and also to a shearing stress originated by the tendency, if there is any, of the machine to slide side or endwise along the top of the foundation. In a properly made installation, however, the anchor bolt does not assume any considerable shearing stress. The reason is that the machine bed plate should be grouted to its foundation, and the grout of itself assumes all lateral stresses.

The real duty of the anchor bolts is then to bind their machine firmly to the foundation on which it rests, so that the machine and the foundation constitute for all purposes a single mass. Where bolts are properly designed and placed the machine cannot move from its position on the foundation unless the foundation moves, or unless something breaks or fails.

TYPES OF ANCHOR BOLTS

FIGURE 1, *I*, shows ordinary machine bolts used as anchor bolts. At *II*, threaded-rod anchor bolts are illustrated, *III* shows a deformed bolt, and a headless-rod anchor bolt is diagrammed at *IV*. Each type of bolt illustrated in Fig. 1 will be treated in detail in the following paragraphs, as will certain other relatively unimportant types. By "unimportant types" are meant those which, while not used frequently, are desirable for certain specific applications.

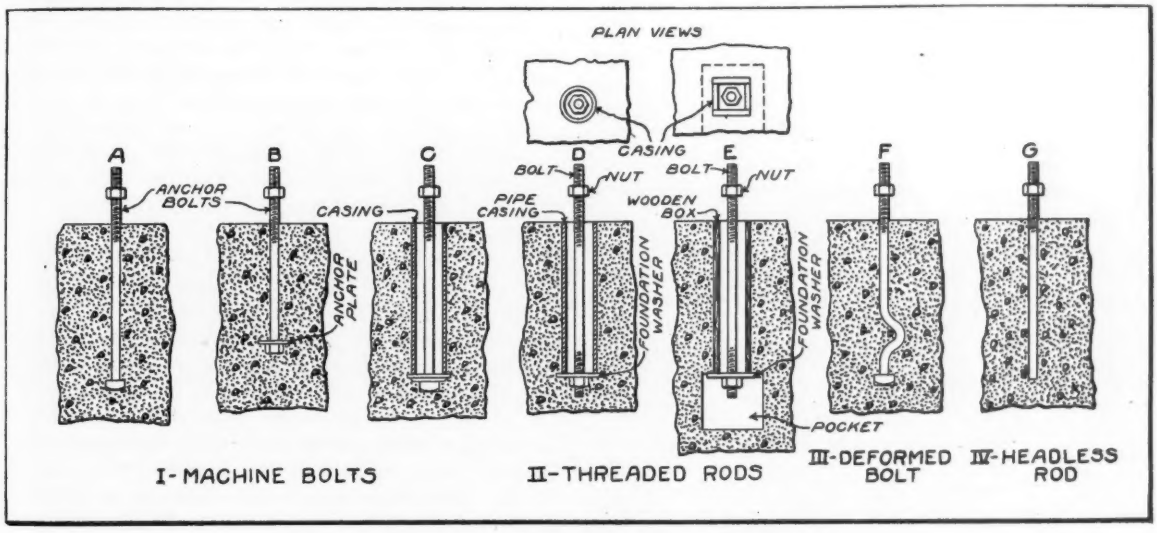


FIG. 1. PRINCIPAL TYPES OF FOUNDATION ANCHOR BOLTS

As to who will furnish the anchor bolts for a given machine or prime mover, there is a question that admits of no general answer. If the machine is an old one, the anchor bolts must be furnished by the owner of the machine. Where the machine is new, that is, where it is being purchased, the anchor bolts may be furnished by either the buyer of the machine or by its seller or manufacturer. The usual practice of machine manufacturers is to try to persuade the purchaser to furnish and pay for the foundation bolts. Where the manufacturer furnishes the bolts, particularly if the machine or prime mover is an expensive one, the bolts are usually included without extra cost. If the buyer furnishes the bolts, this expense is saved to the manufacturer.

There are, however, several good reasons why it is desirable for the purchaser to furnish his own bolts. The first is, that the anchor bolts can, in nearly all cases, be obtained locally and with little delay, whereas if they come from the manufacturer, even though they are shipped in advance of the machine, delay is usual. Furthermore, the length of an anchor bolt for a given application is determined to a large extent by local conditions. Hence the anchor bolts for a certain machine will vary in length depending upon the location where the machine is to be installed. It is for this reason that no machine manufacturer endeavors to stock a line of anchor bolts.

Upon receipt of an order for a machine the manufacturer can generally furnish immediately a drawing showing the foundation bolts necessary and their locations in the foundation. From this drawing the buyer can secure his bolts locally and then start his foundation.

In making a deal for a machine with the manufacturer, it is well to have him include anchor bolts in his price and then when the deal is almost closed he should be asked to omit the bolts and to make a suitable deduction for the omission. Ordinarily it is only in the case of very large machines that it is desirable to follow the procedure just outlined because with small ones the cost of the bolts is inconsiderable. In the large machines the cost may be considerable and the chances are that the manufacturer will include the bolts in his price without increasing his price over what it would be without the bolts, so that if the bolts are finally omitted and a price deduction is made therefor, the buyer effects a saving worth consideration.

The dimensions of anchor bolts are always obtained from the manufacturer when a new machine is being purchased. The manufacturer will always specify the diameters of the bolts required and usually their approximate lengths.

Foundation Bolt Design

In designing foundation bolts, there are 2 points of view to consider. One is that of the buyer of a machine who has merely to select bolts of such proportions that they will meet the requirements specified by the manufacturer. The other viewpoint is that of the manufacturer of the machine who must determine all of the principal proportions of each bolt so that it will safely perform the duties imposed upon it. The buyer of a machine has the bolt diameter predetermined for him by the manufacturer who provides holes in the bedplate of his machine to accommodate bolts of this diameter. The manufacturer often specifies the diameter of the bolt only, then the buyer must determine its length. The factors affecting the design of foundation bolts will now be considered in the following paragraphs from the viewpoints of both the manufacturer and the buyer of a machine.

Clearance desirable between an anchor bolt and the hole for its accommodation in a machine bedplate cannot be determined by any set rules. A good practice where the holes are machined through the bedplate is to allow $\frac{1}{8}$ in. diametral clearance for bolts up to $\frac{7}{8}$ in. in diameter, $\frac{1}{4}$ in. for bolts from 1 in. to $2\frac{1}{2}$ in. in diameter, and $\frac{3}{8}$ in. for bolts $2\frac{3}{4}$ in. in diameter and larger. Where the holes for the bolts are cored in a machine bedplate, clearances 1/16 in. to $\frac{1}{8}$ in. greater than those just specified should be adopted. There should always be some clearance between a bolt and the hole for its accommodation in a bedplate, because if such clearance is not provided, it may be impossible to get the bolts which are built into a foundation into the holes. Such difficulties may be due to the bolts being slightly bent, or to small inaccuracies in measurement in laying out the locations of the holes in the bedplate or of the bolts in the foundation.

Even if the clearance between the bolt and the side of the hole in which it rests is considerable, usually no harm is done. Every machine should, as a general proposition, be grouted on its foundation and this grout would of itself prevent lateral movement of the machine even if no bolts were used.

The tensile strength that an anchor bolt should have is a quantity incapable of determination by mathematical analysis. The diameter of an anchor bolt is determined from a machine manufacturers' standpoint must be great enough that it will safely sustain such tensile stresses as are imposed on it, but it is impossible to determine, even with approximate accuracy, what these stresses will be. The total stress on any bolt is that initial stress due to screwing down the nut on it, plus the stress which may be imposed if there is a tendency toward lifting the machine bedplate from the foundation. In practice, anchor bolt diameters are proportioned in accordance with "rule of thumb" methods based on the experience of the designer.

When a designer is "working in the dark" as he is in such a case, he must be certain that the bolt diameter that he specifies for a given condition is ample.

The minimum diameter of an anchor bolt for general work should be $\frac{5}{8}$ in., as an able bodied mechanic, with an ordinary monkey wrench, can twist asunder a bolt of diameter smaller than $\frac{5}{8}$ in. Hence this diameter is used in many cases where the conditions are such that a smaller bolt might safely sustain the static tensile stresses imposed by the machine itself.

The permissible tension on ordinary wrought iron or mild steel such as that used for foundation bolts is about 7000 lb. per sq. in., but sometimes a tensile strength of 6000 lb. per sq. in. is used. These values give a factor of safety somewhere around 8 or 12, the exact safety factor being determined in any case by the composition of the metal. In figuring the tensile strength of an anchor bolt it is, of course, necessary to take the effective diameter as that at the root of the threaded portion.

When the manufacturer is determining the diameter of a foundation bolt he must consider the strain that the bolt may have to support and then, using his judgment, with the diameters of anchor bolts in successful existing installations as precedents, select a diameter that will certainly be safe.

When the user is determining the diameters of the foundation bolts for a machine where the diameters have not been specified by the manufacturer it is only necessary for him to measure the diameter of the hole in the bed plate through which the bolt must pass and then select a bolt of such a diameter that the clearance between it and the hole will be about that specified in a preceding paragraph.

Detail Plant Costs*

PROPER DIVISION OF OPERATING COSTS; RECORDS FROM TYPICAL PLANTS

IN plants where both steam for heating and electric current are furnished, one is usually the main product and the other the by-product. It then becomes a question how cost of operation shall be divided. If the current is the major product, as in central stations, the question is then put, how much would it cost to produce this if no heat were supplied? Where steam is essential for heating or industrial uses, as in buildings and many factories, the question is reversed. When economies are introduced which affect the cost of both products, each should receive its portion of the saving.

ITEMS NECESSARY

TO APPORTION the costs properly, the following amounts required must be determined with regard to the main or essential product: Fuel; water; supplies, oil, waste, packing; maintenance, including upkeep, repairs and renewals.

Assuming that the current is the main product, these items will be considered in order.

FUEL

DURING TIMES when exhaust or live steam are not needed, all fuel is, of course, made for the electrical department. Fuel should be determined per kilowatt-hour generated and then this unit figure can be used as a factor throughout the year. While this method is not strictly correct, the factor found this way will for all practical purposes be sufficiently correct. It will, of course, be affected from month to month by:

1. The temperature of the circulating water entering the condensers, if the plant runs condensing in the summer time.

2. The station output changes from time to time with a consequent increase of decrease in coal per kilowatt-hour.

3. The periods of banking fires change, being longer in some months than in others.

But on the whole the 3 chanees for error above given are not sufficiently serious to change the ultimate result. If, therefore, a careful record of the coal per kilowatt-hour is kept, say from June 1 to Sept. 1, this factor can be satisfactorily obtained.

Having obtained this factor, the difference between this amount of coal and the total amount of coal used in the heating months would be the amount of coal to charge to the heating department. An arrangement of this kind takes into consideration the back-pressure conditions, if any are created due to the heating system, and also allows full credit for any vacuum which the heating system might put onto the prime movers during the heating season.

LABOR

LABOR REQUIRED during the non-heating period will always include a portion of the chief engineer's salary, and a certain amount of boiler-room labor. Oftentimes the heating department's requirements can be produced without any additional labor in the boiler room, and at least without any additional expense for the chief engineer. Consequently it is probably equitable to allow the major product, in this case the electrical department, a credit by not charging the entire chief engineer's salary to the electrical department, but prorating it into the 2 departments. It is also probably equitable to divide the boiler-room expense according to the tons of coal handled, and prorate it according to the amount of coal required in each department.

WATER

ORDINARILY the amount of water used will follow very closely the amount of coal consumed, especially if it is an exhaust steam heating plant. The amount of water used per kilowatt-hour in the non-heating period would control throughout the year's calculations.

SUPPLIES

OIL, WASTE, and packing can be distributed properly by considering on what apparatus these supplies are used. It is obvious that the supplies for the prime movers shall be charged entirely to the electrical department and the supplies for the boiler-feed pumps, service pumps, and other apparatus used jointly by the 2 departments can be prorated according to the use of the apparatus.

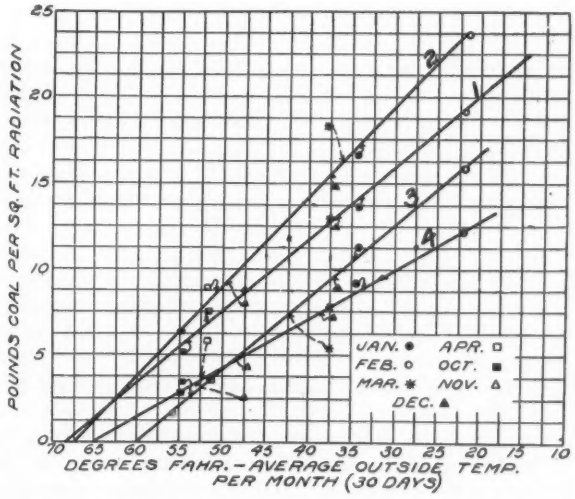


FIG. 1. AMOUNT OF COAL REQUIRED PER MONTH PER SQUARE FOOT OF RADIATION FOR HOT WATER HEATING PLANTS DURING VARIOUS OUTSIDE TEMPERATURES

MAINTENANCE

MAINTENANCE in the boiler-room of boilers, stokers, arches, and auxiliary equipment should be prorated according to the amount of coal charged to each department. It is obvious that the maintenance of the prime movers should be charged to the electrical department.

*From a committee report to the National District Heating Association.

In the accounting of a system other details and refinements can be carried out, such as the cost of coal per thousand pounds of steam, or cost of labor, water, and maintenance, per thousand pounds of steam. This, it seems, is as important as any point.

Diagrams herewith show points of interest relative to the accounting and cost-keeping system in a combination electric-heating plant.

Figure 1 shows the amount of coal required per month per square foot of radiation for hot-water heating plants during various outside temperatures.

Curve 1 is for an electric and heating plant with division of coal during the heating season very good. The engines run at atmospheric back-pressure the entire year, but exhaust into surface condensers during the heating season. The electric load factor is 22 per cent, and 31 per cent of the yearly coal is charged to heat.

	Bldg. 1	Bldg. 2	Bldg. 3	Bldg. 4	Bldg. 5	Bldg. 6
Number of Days.....	15	4	5	4	46	151
Steam Gen., 1,000 lbs.	1,611	362	485	124	10,310	36,890
Tons of Coal, gross..	117	27.6	30.3	11.3	783	2540
Rate of Evaporation.	6.15	5.84	7.13	4.94	5.89	6.31
Aver. Outside Temp.	30.7	34.2	39.6	37.0	34.8	40.9
Boiler Capacity, hp..	384	600	600	800	1200	900
Max. Boiler hp.....	280	300	330	150	600	850
Aver. Boiler hp....	100	80	150	50	235	350
Cost per 1,000 Lbs. Steam.						
Coal	$0.191	$0.201	$0.165	$0.238	$0.203	$0.187
Labor	$0.049	$0.085	$0.079	$0.251	$0.052	$0.056
Ash Removal	$0.010	$0.011	$0.009	$0.021	$0.008	$0.007
Water (makeup) ...	.....	.....	.....	.....	$0.007	$0.001
El. Cur. (forced dr.)	$0.014	$0.005	$0.007	$0.021	$0.008	$0.006
El. Cur. (B.F.Pump)	.....	.....	$0.007	.....	.....	.....
Supplies	$0.004	$0.011	$0.006	$0.002	$0.004	$0.006
Repairs & Misc.	$0.004	$0.004	$0.002	$0.001	$0.003	$0.002
Total	$0.272	$0.317	$0.275	$0.535	$0.285	$0.265
Fixed Chg. on Invest.	$0.029	$0.051	$0.054	$0.084	$0.044	$0.033
Total Cost per 1,000 Lbs.	$0.301	$0.368	$0.329	$0.619	$0.329	$0.298

FIG. 2. OPERATING DATA FROM 6 NEW YORK OFFICE BUILDINGS

Curve 2 is for a turbine plant run noncondensing in summer, and exhausting into large surface condenser during the heating season under vacuum. Load factor is 46 per cent and 26 per cent of yearly coal is charged to heat. Live steam is used to heat the water when electric load is light.

In Curve 3 the electric load carries too large a part of the coal bill. Engines run noncondensing the entire year, but exhaust at slight back pressure into surface condensers when heating and some live steam is used.

Curve 4 is for a combined turbine and engine plant, running noncondensing the entire year, but with surface condensers for heating the water during the heating season. Division of coal is not good.

Data from 6 New York office buildings are interesting as showing the items that enter into steam cost and how these vary with good and bad operation. In all plants No. 3 Scranton anthracite buckwheat coal is burned with balanced draft, costing delivered about $2.50 a ton.

No. 1 is a 25-story office building covering 9000 sq. ft. ground with a restaurant on the top floor which uses steam for cooking throughout the day. Two Heine boilers are run at 70 lb. In summer the plant is shut down and steam taken from street supply.

No. 2 is a loft building of 12 stories containing 4,000,000 cu. ft. and requiring steam for industries in large amounts throughout the year, 24 hr. a day.

No. 3 is offices, 25 stories high, with 6,500,000 cu. ft. contents. Two Erie City water-tube boilers are operated at 30 lb. pressure, all accessory pumps being electric-driven by street current. In summer the plant is shut down and a heater furnishes hot water.

No. 4 is an older loft building, an example of extravagant operation, with no thought except continuous service.

No. 5, a department store, containing 15,000,000 cu. ft., uses steam for cooking, refrigeration, cash tube, hot water and heating from 4 B. & W. boilers.

	Operation for the Year	Per cent. of Total Operations.	Per cent of Gross Earnings
Operating—			
Supt. and Labor	$ 3,062 27	13.6	7.2
Fuel	12,453 17	55.3	29.2
Miscellaneous Supplies	58 10	00.3	00.2
Total Operating	$15,573 54	69.2	36.6
Maintenance—			
Heat Plant and Equipment	$ 321 10	01.4	00.8
Mains	535 94	02.4	01.3
Services	656 04	02.9	01.5
Total Maintenance	$ 1,513 08	06.7	03.6
Distribution Expense	$ 241 60	01.1	00.6
Commercial Expense—			
Collection Salaries	$ 73 24	00.3	00.2
Uncollectible Account	92 50	00.4	00.2
Promotion Business, Salaries and Sup.	207 00	00.9	00.5
Total Commercial	$ 372 74	01.6	00.9
General Expense—			
Salaries, Officers and Clerks	$ 1,468 99	06.5	03.5
Office Rent and Supplies	230 55	01.0	00.6
Miscellaneous Gen. Expense	477 67	02.2	01.1
Insurance	397 51	01.8	00.9
Stationery and Printing	148 10	00.7	00.4
Opr. Stores Dept. & Utility Eq.....	83 96	00.1	00.1
Taxes	1,873 51	08.4	04.4
Refunding Expense	136 80	00.7	00.3
Total General Expense ...	$ 4,817 09	21.4	11.3
Grand Total	$22,518 05	100.0	53.0

FIG. 3. OPERATING EXPENSES OF A TYPICAL COMBINATION HOT WATER HEATING AND ELECTRIC PLANT

No. 6 has an isolated boiler plant with a run of 750 ft. for the building. The plant which operates only during the heating season has 3 B. & W. units, 2 in battery, at 100 lb. pressure.

In the short time during which the observations were made, it was found advisable, in all the plants regardless of size, to install either feed water or steam flow meters to give the engineers and firemen some idea of the work being done by the boilers.

The importance of the installation of meters for indicating the load on boilers cannot be over emphasized. It has been frequently observed that in individual plants boilers were evidently not being worked at near their rated capacity, and a test with suitable meters has shown, in some cases, that 900 b.hp. capacity was in service to carry a 300 or 400 hp. load.

In one plant, which is a combination hot-water and electric property, the gross income from heating is $42,501.90. The operating expenses were $22,518.05, divided as shown in Fig. 3.

Superheated Steam Cylinder Lubrication

OILS USED IN CONNECTION WITH SATURATED STEAM UNSUITABLE FOR SUPERHEAT SERVICE. BY W. J. FOUHY

SUPERHEATED steam differs from ordinary saturated steam to the extent of its higher temperatures and pressures, and its greater degree of dryness. In other words, it much more nearly approaches the perfect gaseous state than either wet or dry saturated steam.

The higher temperatures promote greater expansion of the cylinder metal, and in many instances, unequal metallic expansion or slight distortion of the parts, or slight warping of the internal working surfaces.

Such distortions tend to promote more or less binding and groaning of valves, and unequal wear of the internal working surfaces during service. They are brought about more or less by unequal distribution, and thickness of metal; by spongy or porous metallic spots, and by unequal exposure of the internal surfaces to the maximum heat or steam temperatures. These difficulties of engine operation due to unequal metallic expansion, however, are more observable in new engines than those installed or in service for a few years, and they are now less common than during former years; in fact, serious difficulties of this kind are now exceptional.

The higher temperatures together with the greater velocity of high pressure and superheated steam, also serve to decrease the resistance of the metal against breakdown to some extent or to promote injury to port edges, and the effective working edges of engine valves. This is particularly true of engine cylinders composed of ordinary grades of castiron, where the maximum steam temperatures exceed about 400 deg. F.

Recognition of the foregoing effects of intensified heat or high steam temperatures during past years by responsible engine designers and builders, prompted improved design, and the use of superior metals or mixtures in the construction of steam engine cylinders for superheated steam service. Such observations also served to discourage the use of highly superheated steam in a measure, or to limit *steam superheating* largely to 125 deg. F., or less.

Furthermore, the use of superheated steam for power purposes or the intensified heat of same was also investigated and recognized by responsible petroleum oil refiners, and this led to the bringing forward of special cylinder oils for superheated steam service. It developed later, however, that this did not fully solve the problem or that it proved to be only one of the necessary steps, and that special attention to cylinder oil application was required. In other words, subsequent observations led responsible engineers to the conclusion that the greater dryness of superheated steam made the atomization of steam cylinder oils more difficult than a saturated or wet steam condition, and this fact led to the introduction of steam condensation with the oil prior to atomization. It also led to the bringing forward of special atomizers for this purpose.

After atomization of any steam cylinder oil, the steam heat naturally increases its fluidity or serves to decrease the body of the films of oil deposited on the internal working surfaces. In fact, the higher the maximum steam temperature, the greater will be the immediate thinning-down process, provided the oil is capable of withstanding the heat prior to further radical change while in service. However, the higher temperatures of superheated steam have proved excessive for satisfactory and efficient lubrication from many brands of steam cylinder oils. For these reasons, special attention should be given to the maximum steam temperatures when selecting or recommending a steam cylinder oil for superheated steam cylinder lubrication. Evidently, superheated steam cylinder service differs from saturated steam cylinder service to the extent of the effects produced by the "higher temperatures," and its greater "dryness."

Experience also teaches that 600 W. cylinder oil, Superla cylinder oil, and their equivalents, are well suited for superheated steam cylinder conditions where the maximum temperatures do not much exceed 425 deg. F., and that such oils render more efficient service under such conditions than pure mineral cylinder oils. Also, that Superla S. H. cylinder oil, Gargoyle Hecla B. cylinder oil, or their equivalents, are usually better suited in cases where the maximum steam temperatures greatly exceed 425 deg. F. when entering steam cylinders.

Some reliable and closely observing engineers prefer to use 2 distinctly different cylinder oils with superheated steam; that is to say, a suitable oil for the high-pressure cylinders, and a quick-acting steam cylinder oil in the low-pressure cylinders of compound or multi-expansion engines. This is safe practice or it is in accord with the lower pressures and temperatures or the increasing steam saturation that prevails more or less within low-pressure cylinders. On the other hand, the experiences of other careful engineers who are contented with the use of one oil suitable for superheat, in high and low-pressure cylinders of compound engines, suggest that the use of a quick-acting steam cylinder oil is not necessary in every case of superheated steam, and compound engines.

It often happens that the successful growth of a manufacturing enterprise or of a steam power plant, together with the advantages afforded by high pressure and superheated steam, prompts its management to install at some time or other either high-pressure boilers, superheaters, or both, and to use either high-pressure or high-temperature steam instead of the former use of low or medium-pressure saturated steam in the engines.

In such cases either Capitol cylinder oil or others well suited to the former saturated steam, load, and other conditions may have been used satisfactorily prior to the improved installation; but this is no indication that the same cylinder oil will serve when subjected to greatly higher steam temperatures in the same cylinders. In fact, an attempt to use such former cylinder oils under the changed conditions of very high pressure, or superheated steam, invariably proves unsatisfactory to all concerned.

From the foregoing, we must conclude that superior cylinder metals; the use of suitable steam cylinder oil or oils, and the use of special atomizers are 3 requisites of successful and efficient superheated steam cylinder lubrication.

Dry Air for Power Uses

TROUBLES FROM MOISTURE; FACTORS WHICH DETERMINE THE AMOUNT; GETTING RID OF EXCESS. BY FRANK RICHARDS

IN a recent interesting account of the compressed air installation for driving a tunnel, are mentioned 2 compressors each with a rated capacity of 427 cu. ft. of free air per minute. Air was conducted to 2 receivers in the compressor house, one being 3 ft. in diameter by 8 ft. 3 in. long, and the other 3 ft. 6 in. by 8 ft., then into the mine through a 4-in. pipe 3725 ft. long, more than ⅔ of a mile, to a receiver 3 ft. 6 in. by 8 ft., thence 350 ft. through a 3-in. pipe line to the starting point of the tunnels, and through 3-in. branch lines to within 50 ft. of the faces.

Compressors were placed outside the mine mainly to insure getting dry air, as the atmosphere inside the mine contains a large amount of moisture due to the sprinkling to lay the dust and the natural wet condition of parts of the mine. By having the compressors outside the mine, no trouble whatever was experienced from the freezing of the air drills.

The statement relating to the compressed air supply, and the complete avoidance of the freezing-up trouble, seems to call for some comment since, as it stands, it embodies a prevalent misunderstanding as to the conditions to be observed in successful compressed air practice.

Those who have had much to do with the use of compressed air for driving rock drills, pumps, etc., are sufficiently familiar with the annoying presence of water in the air, and of the trouble it is apt to cause by freezing up and choking the exhaust passages. This was certainly not lost sight of in the description above referred to, since we are told in it that the compressors were located outside the mine "mainly to insure getting dry air," and also that "by having the compressor thus outside the mine, no trouble was experienced by the freezing at the air drill."

Of course, the story as told is true, and I have not the slightest doubt as to the facts or experiences narrated; it is only the deductions or explanations given about which there can be any question. Locating the compressor outside the mine for the purpose of getting dry air, and then the happy experience with the drills when there was no free moisture to freeze, and therefore no freezing up, had not the slightest relation to each other as cause and effect.

A little reflection must suggest at once that hundreds of compressors have been thus located outside mines and tunnels, where all of them could have been expected to get dry air just as surely as in this case; and yet it has been the rule rather than the exception that the drills or other tools driven by the air from these compressors have had a persistent habit of freezing up, not alone on account of the low temperatures of the exhaust, but also, and principally, because water was present in sufficient quantity to accumulate in the form of ice in the exhaust passages. Evidently something more is needed than the location of the compressor in this case to account for the immunity, and it is not difficult to trace the missing link.

No Air Is Dry

THERE IS no such thing as dry atmospheric or "free" air. Whenever air is spoken of as "dry" it is only that it is drier than some other air. And how could it be otherwise, when one of the most important and perpetual functions of the air is the conveyance and distribution of water over the earth? Air is always drier in some places and wetter in some places than in others. Here are a few local mean percentages of atmospheric humidity from tables of the U. S. Weather Bureau: Galveston, 85; New York City, 73; Walla Walla, Wash., 65; Rapid City, S. Dak., 60; Salt Lake City, 53; Yuma, Ariz., 42; El Paso, 39. It is somewhat curious that the places of the highest and the lowest humidity in the United States are thus both in Texas.

Moisture which is thus intermixed with the air is in the form of perfectly transparent and invisible vapor, until a humidity of 100 per cent, or the point of saturation, dew point, is reached, which may be said always to occur in the compression and transmission of air at the ordinary working pressures, say 6 atmospheres or 75 lb. gage, and immediately that this point is passed, the excess of moisture condenses into actual water, but still mixed with the air, the super-saturated air then appearing as fog or mist. The freed water which forms the cloud will slowly settle out of the air if it is quiet long enough; if air in this condition is passing through a pipe, the water will wet the interior and trickle down to the bottom, where in time it will form a flowing stream and be carried along with the air current.

The saturation point of air constantly varies, and is determined by its pressure and its temperature, especially the latter. At a fixed temperature any given volume of air is saturated when it contains a certain quantity of water vapor, and this almost regardless of the pressure, which affects the capacity of air for water vapor only by changing the volume. If the absolute pressure of the air is, say, doubled, by which the volume is reduced one half, the moisture capacity is reduced in the same proportion, so that, if the humidity of the free air is 50 per cent, this humidity becomes 100 per cent when the air is compressed to 2 atmospheres or 15 lb. gage, and if it is compressed to 6 atmospheres, 90 lb. absolute, or 75 lb. gage, a very common working pressure, the humidity becomes 300 per cent, and 200 per cent of this the air will refuse to carry.

That is, it would so refuse to carry this excess of moisture if its temperature remained constant, which thus far we have assumed to be the case; but that is far from the fact. As air is compressed its temperature rises rapidly, and with each rise of about 20 deg. its capacity for moisture is doubled. Starting with free air at 60 deg. F., if it is compressed to 75 lb. gage, its temperature at delivery, no matter how perfectly the cylinder may be water-jacketed, will be above 300 deg., so that in consequence of this change of temperature, the capacity of the air for moisture will have been

doubled so many times that when it leaves the cylinder the relative humidity will be quite low, although it still carries all the moisture with which it started. It might be called exceedingly dry air, and with the receiver placed near the compressor, as it generally is, its temperature in passing through the receiver will still be too high for it to get to a condition beyond saturation and release the water; and, as a matter of fact, under the conditions here suggested, little water is ever drawn from air receivers so located.

It is to be borne in mind that the conditions under which compressed air will have the lowest capacity for moisture are high pressure and low temperature. As the air leaves the compressor, and before it begins to be used, it is of course at its highest pressure, and in its flow through the pipes its temperature is reduced, so that when it arrives at the point where its work is to be done it should be at a low temperature and carry a minimum of moisture, if the opportunity has been provided for getting rid of the moisture as it condenses.

In the case under consideration, the air was conveyed through the pipe line more than ⅔ of a mile, and we may be sure that it was thoroughly cooled by the time it got to the end. Long before it got there, the saturation point was reached, and the water began to wet the pipe and to flow along the bottom as previously mentioned. This water would finally be carried into the receiver which, fortunately, was provided at the far end of the pipe, and other moisture would separate from it while passing through the receiver, all of this water being drawn off from time to time. It was the presence of this receiver which prevented the drills from freezing up, by intercepting the moisture before it could get to the drills, not the locating of the compressor outside the tunnel, which really had nothing to do with it. A receiver or some means of catching the water after the air has made its run through the pipes is necessary, but it is not easy to see the use of the receivers near the compressor, if the line pipes are of reasonable size.

When 2-stage compressors are employed for ordinary working pressures, as is always to be recommended and is now quite customary, a little of the water may be intercepted in the intercooler, and much of it would be liberated by an aftercooler; but a receiver or a water separator at the end of the run is generally necessary to complete the work. More or less water is sure to be in the air in excess of its capacity, and its presence will assert itself if it is not disposed of.

Unique Engineering Project in Utah

LARGE TUNNEL DIVERTS RIVER FROM EASTERN TO WESTERN SLOPE, MAKES POSSIBLE THE RECLAMATION OF 60,000 ACRES OF LAND AND DEVELOPMENT OF POWER. BY A. P. CONNOR

THE history of this project is one worthy of the engineering profession, because it illustrates the overcoming of obstacles that are beyond the comprehension and patience of all who are not imbued with the engineering spirit. The project was turned over to the Reclamation Service by Congress to take care of, or, in other words, accomplish. Its location is in the State of Utah in the vicinity of the Wasatch Mountains and the Strawberry and Spanish Fork Rivers. The first obstacle found in the way of the construction of the tunnel that was to pierce the Wasatch Mountains and convey the Strawberry River through them, was the fact that there was no one willing to take the contract. This left the problem entirely in the hands of the Government and with due procedure the building of the tunnel was started. At first a steam operated plant was utilized for giving the power to bore the canal through, or rather operate the drilling and incidental apparatus used for the purpose. In a short while, this kind of plant was found to be at a disadvantage and steps were taken to make use of the Strawberry River to develop water power. For this purpose, the river was dammed, a power station installed and a connecting pipe put between the two. The tunnel is 19,897 ft. long, but is usually called 4 miles long.

The Strawberry River, which is now caused to flow through the tunnel connected with the eastern side of the States, in the natural course of events found itself in the Gulf of Mexico. The direction of the river is now turned to the Pacific coast and the part of it that is not used for power and irrigation purposes leads to the Great Salton Basin. In other words, the Gulf of Mexico has been cheated out of a river.

There are other tunnels on the project, one known as No. 1, which is 800 ft.; No. 2, which is 705 ft.; Aqueduct, which is 750 ft., and the High Line Canal, which is 230 ft. long.

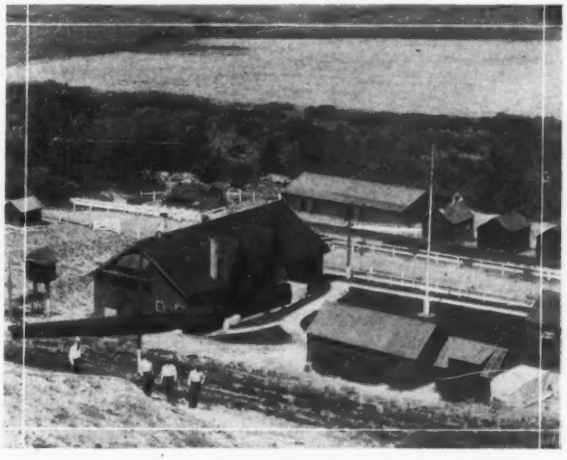


FIG. 1. MAIN POWER HOUSE AND PENSTOCK IN STRAWBERRY VALLEY

In the construction of the tunnels and particularly the main one, underground rivers were run into and caused considerable trouble, together with incidental caving in of the tunnel.

The water of the Strawberry River is stored in a suitable reservoir and the dam consists of a concrete core covered by a rip-rap filling. The power plant is about 3¼ miles below the dam, and the power will

eventually be used for pumping water for the project. It supplies 3 towns with electricity at the present time under contract, as well as providing sufficient for the power needs of the construction. The plant now has 2 horizontal 800-hp. turbines and 2 500-kw. generators. The total proposed power development will utilize about 3500 hp.

through the sides comes from the mountain springs. The end of the high-line canal is shown, and is unique because the arrangement of the concrete construction is adapted for 3 purposes: to control the flow as well as direct it to the penstock of the power plant, to divert the overflow of water to a special tunnel, and to provide means for controlling the flow of the canal to its future

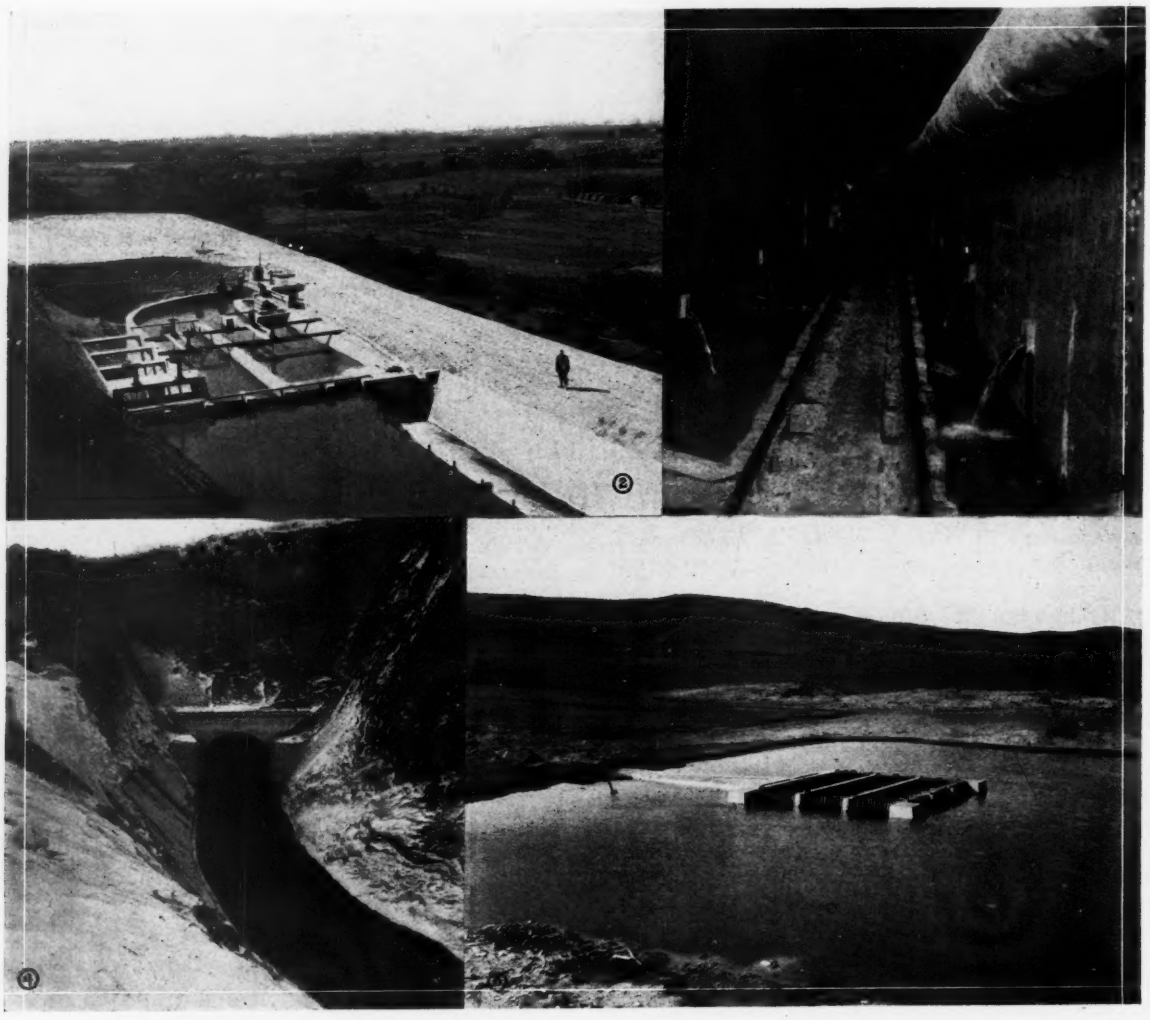


FIG. 2. GATEWAY ON HIGH LINE CANAL, SHOWING ENTRANCE TO POWER TUNNEL OF PENSTOCK, THE OVERFLOW TUNNEL AND THE END OF THE CANAL TO BE EXTENDED

FIG. 4. PORTAL OF ONE OF THE POWER TUNNELS

FIG. 3. INTERIOR VIEW OF MAIN MOUNTAIN TUNNEL DURING CONSTRUCTION

FIG. 5. INTAKE IN STRAWBERRY BASIN LEADING TO THE MAIN MOUNTAIN TUNNEL

After the water goes through the main tunnel, it flows to the Diamond Fork River, which is a tributary of the Spanish Fork River, and the latter river is diverted into canals for irrigation purposes. The head of water for the power plant is 125 ft. The land to be irrigated is 30 mi. away from the reservoir or basin.

In the illustrations will be seen the grating through which the water flows, in the reservoir. This grating serves to keep out the large pieces of debris that might otherwise get into the tunnel. The interior of the main tunnel is shown and the water shown pouring in

extension. The overflow is shown to the right of the picture near the front, the penstock control is farthest away and the extension provision is to the left of the canal.

THE FIRE LOSS for the last 12 yr. has been at the rate of $500 a minute. If we were to throw that amount of cotton, wheat or any other staple away we would soon see that we were becoming impoverished. There is no country that can stand such a drain.—Franklin H. Wentworth, Secretary National Fire Protection Association.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Packing on Top of Packing

IT IS sometimes the practice when the piston rod or valve stem needs it to add a ring or 2 of fresh packing, and later on, when again needed, to repeat this performance. Not much effort is made to find out the condition of the rings placed in there in the dim past, whether they are hard and burned, or whether they have worked through into the cylinder.

Some time ago it was my lot to examine a Corliss engine as to its need of repairs. On removing the valve stems, some were found to be worn half through in the stuffing box. The packing in the bottom was hard, so hard, in fact, that a cold chisel was needed to cut it out. The man who ran this engine had neglected to take out the packing occasionally, but had simply added new rings and let it go at that. When the packing gets in this condition, it is worse than worthless. The stem gets scored, and the stuffing box will leak, unless the gland is set up tight; this, of course, increases the friction and the wear on the stem. It is well, when placing new packing, to use a mixture of graphite and cylinder oil with it; this is especially good on a new rod.

A piston rod can be easily scored, or burned if the packing is too tight; it is better to leave it a little loose, even though the steam does leak through. The gland can be gradually taken up.

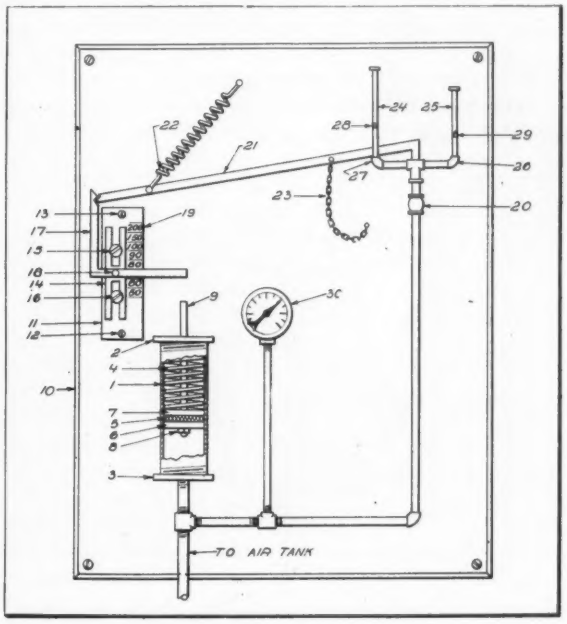
If a piston rod has too much clearance in the bore of the head, a ring made of brass or babbit can be placed in the bottom of the stuffing box, to keep the packing from pulling through into the cylinder. The ring should be bored a trifle larger than the rod, say 1/32 in., and the outside diameter at least 1/32 in. smaller than the inside diameter of the stuffing box.

Where ring metallic packing is used on a new rod, it is well to break in the rod with a soft packing, running it this way for a few weeks. The rod will acquire a good polish and surface. TOM JONES.

Safety Signal for Air Tanks

THERE IS no certainty as to when a pop valve and an automatic cutout switch on an electric-driven air compressor will work. A certain amount of oil is carried through the air lines from the compressor and will lodge in the valves of the cutout switch and around the seat of the pop valve and form a gum, causing the valves to stick.

One never knows when the pop valves are going to be stuck or when the ports in the cutout switch on the compressor are stopped up. I have rigged up, as shown in the sketch, what seems to be a simple and reliable safety signal, which can be made by any ordinary mechanic. As there is no air passage through the cylinder to carry the oil, there is no chance of the piston, 5, becoming stuck in the cylinder, 1, with gummy oil, and as the piston moves up and down as the air pressure varies, it is thus prevented from becoming stuck. I have the signal set so it will operate at 10 lb. above the setting of the automatic cutout switch and twice it has signaled that the automatic cutout switch failed to operate. The pop valve is set to release at 20 lb. above the setting of



AIR TANK SIGNAL

the signal. The signal consists of a few pieces of ⅜ or ¼-in. pipe and a few fittings, a piece of 1¼-in. brass pipe, 1, 9 in. long and threaded on both ends; 2 and 3 are 1¼-in. pipe caps forming the cylinder; 4, a coil spring; 5, a leather washer; 6 and 7, iron washers; 8, a nut; 9, the piston rod; 10, the board on which the signal is mounted; 11, a piece of copper ¼ in. thick, ½ in. wide and 6 in. long held to the board, 10, by screws 12, 13; and 14 is copper ¼ in. thick, 1 in. wide and 4 in. long, slotted at both ends, and held to 11 by screws, 15 and 16; 17 is a latch loosely held to 14 by a screw, 18; 19, pressure gage marks; 20, stop cock; 21, stop cock lever; 22, coil spring for opening stop cock when latch, 17, is disengaged from lever 21; 23, stop chain for lever 21; 24 and 25, dog whistles made of brass pipe (2 sizes, ½ and ⅜ in.), the ends to be screwed in ells,

26 and 27, and filled with solder to a level with the holes sawed in the pipes at 28 and 29. A small hole is drilled in the solder on the side of the pipe that holes 28 and 29 are cut, the top being closed with pipe caps or filled with solder; 30 is the pressure gage. To gage the signal, relieve the pressure on the storage tank, set the slide, 14, at the lowest position, then start the compressor and note the pressure on the gage when the latch is disengaged from the stop cock lever. Mark the pressure on 11 at 19, move the slide up and note the pressure at the next release of the latch and mark, and so on until the slide has been moved to the highest point. Now, set the slide, 14, at the desired pressure and the job is completed.

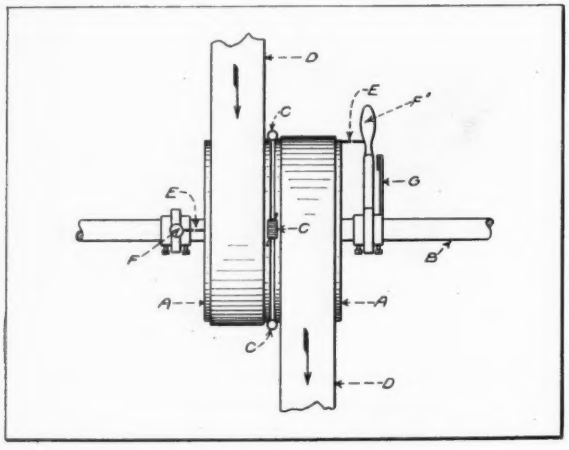
J. B. LINKER.

A Simple Dynamometer

HEREWITH is a sketch of a transmission dynamometer I once made for rough work in a college laboratory. The scheme is simpler than any other I know of.

A, A are loose pulleys mounted on a rigid shaft, B. They are connected by means of closed-coil springs C, C, C (4 of them), arranged 90 deg. apart. These springs were attached to the spokes of the pulleys, but they may be attached directly to the pulley rims if desired. D, D are belts carrying the load to be measured.

Thus, when the belts are under stress, the coil springs are forced to stretch, the stretch being proportional to



HOME-MADE DYNAMOMETER

the stress in the belt. All that is necessary, then, is to know the degree of stretch in the coil springs.

This is easily accomplished electrically by use of wipe-contact-points E, E. Put one contact point on each pulley, as indicated, and one on each of 2 levers, F, F^1. F is a rigid lever; F^1 is adjustable and calibrated with a rigid quadrant, G.

To calibrate this dynamometer is a simple matter: Hold one pulley rigid and suspend weights from a tangent to the periphery of the other pulley in such a way that the springs will be stretched. Make marks with quadrant G corresponding with all pulls from 0 lb. to maximum pounds with suitable increments—depending on the magnitude of the maximum force. The correct setting on G is located by passage of current through the contact points.

Then when the dynamometer is in actual use, lever F^1 is shifted until a current passes through the contact points, the reading on G is noted, and from the calibration data it is easy to compute the horsepower transmitted by use of this formula:

$$\frac{3.1416 \times 2 \times R \times P \times N}{33{,}000} = \text{Hp.}$$

Where R is the distance from the center of the shaft to the middle of the belt in feet;

P = Pull in pounds—the calibrated measurement marked on the quadrant;

N = r.p.m.

It is evident that the contact points on F and F^1 should be insulated from the shaft. A telephone receiver in the circuit will indicate when the lever, F, is in the proper position for the load.

There are other things that are quite evident without further description. The engineer's judgment should enable him to make one like or similar to this with little difficulty.

N. G. NEAR.

Automatic Switch and Alarm

WE WERE having considerable trouble with a leaky pump which was located in a pit directly under a 100-hp. motor that was used to run it. The pit used to fill up and the water ran on the belt, causing it to slip and run off.

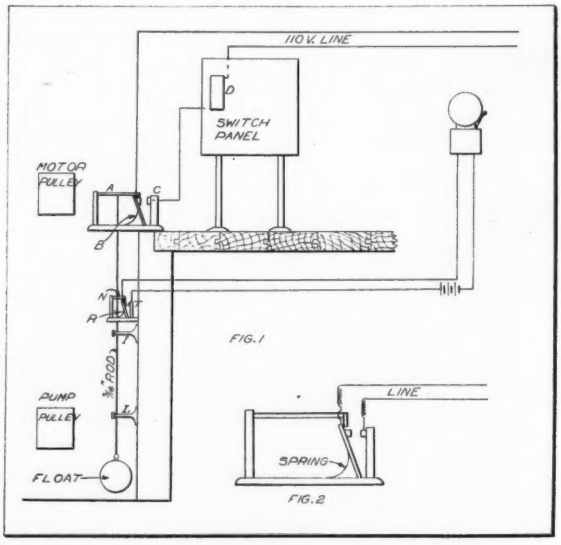


FIG. 1. SWITCHING CONNECTIONS FOR GIVING ALARM AND STOPPING PUMP

FIG. 2. DETAIL OF AUTOMATIC SWITCHES

Then I made the following arrangement: The rod of 3/16-in. iron is connected to the float and run through the guides, I I, fastened to the wall. When the water rose high enough to lift the lever, N, on the automatic rig, T, the little lever, R, closed the circuit and caused a bell to be rung in the mill; if this was not heeded in a few minutes, the rod lifted the lever, A, closing the circuit by releasing lever B, which operates by a spring; this closed the circuit on the magnet, D,

and opened the circuit breaker, being connected by a string to the overload trip.

Figure 2 gives a detail of how the 2 switches work. The first switch, T, in Fig. 1, works before the one operating the circuit breaker, so that any one could bale out the water before any damage was done. This was fixed by putting a little piece of iron on the rod, as shown at N. This rig worked fine, and a saving in expense resulted. GEO. MACLEAN.

Transmission Line Losses

IN REGARD to the discussion of this subject on page 647 of the July 1 issue, I wish to call attention to the fact that in a 3-phase system, if the system is balanced and there is the same size wire used in both systems, the line loss for the 3-phase system is exactly half that for a single-phase system. In the figuring of the loss as shown, the results are about correct, and the loss for the 3 phase is computed at practically half that for the single phase.

Using the same size wire, the cost of the copper wire will be 50 per cent more for the 3-phase than for the single-phase, not 3 times as much, also the labor cost will be less than 50 per cent more, since there is only one additional wire to erect and no additional pole line.

In regard to the tempering of steel, on the same page, in the method we use, the steel is heated to a cherry red and plunged into water, then heated up gradually until the color is right, then plunged again. If it cools below the red heat before it is plunged, we find that it will not harden. Set screws, case-hardened, will probably not have a good temper after annealing.

HARRY D. EVERETT.

Repairing Hole in Pump Casting

WE HAVE a pump of the duplex piston packed type used for circulating salt water to condenser coils and jackets for compressors, etc. Some time ago, this pump knocked badly and sometimes stopped.

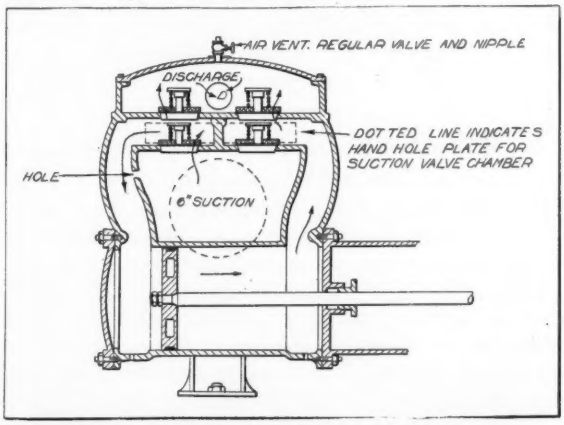

AIR VENT. REGULAR VALVE AND NIPPLE
DISCHARGE
DOTTED LINE INDICATES HAND HOLE PLATE FOR SUCTION VALVE CHAMBER
HOLE
6" SUCTION

FIG. 1. LOCATION OF HOLE IN PUMP CASTING

We overhauled the water end valves and put new springs in, then tried the pump again. It still worked badly, so we ground in the steam slide valves and tested the steam pistons for tightness, and thought it was all right. We then put new packing in the water pistons and still it would not work and had a greater tendency to stop.

We then decided to strip the water end completely. As shown in Fig. 1, dotted line represents cover on suction valve chamber. This was taken off again, also blank flange, for inlet to suction side. Putting a light inside, we discovered a hole, as shown in Fig. 1, which appeared to be about ¼ to ½ by 1.5 in.; that is, it tapered or narrowed as it wore through, to the other side connecting with the cylinder. This, of course, caused our trouble.

The method of repair was as follows: 2 pieces were shaped as shown at B, Fig. 2, drilled for a ⅜-in. stud

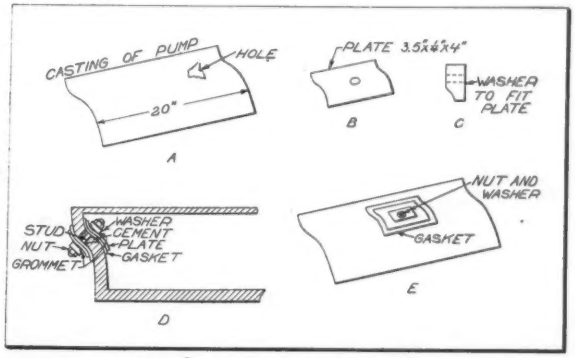


FIG. 2. DETAILS OF THE REPAIR

and formed to the curvature of the casting; also 2 rubber gaskets were cut to cover everything, and larger than the plates, and a stud ⅜ by 1⅝ in. was made. A nut was used as a washer and shaped as at C, with the grommet around washers on the inside, a single nut being used on the head end side. Figure 2 gives an idea in details of what was done.

The operation of closing the hole was in this manner. The helper shoved the gasket and plate up together and put in place, with the nut over the hole. The stud was put in from the inside and caught the outer nut in this way. When the inner plate and gasket were put on with washer and grommet and the whole drawn up tightly. D shows the hole plugged and finished. Altogether it was rather difficult, as you could not get your hand up to hold the plate, gasket or nut on the outside, and the plate and gasket were close to suction valve deck on the inside.

On the whole, the job seems to be quite complete for the present, as the pump works excellently; but the query is, how long will gaskets of rubber last in salt water?

F. J. MCDONALD.

Cutting in Boilers of Unequal Pressure

IN THE July 1 issue, H. K. Scholefeld discusses cutting in boilers of unequal pressures. He appears to be under the impression that his method is at variance with established practice. So far from his method being "against all theory of good practice," it is shown to be strictly according to good practice when he states that "no sane attendant would throw his valves open at once. Common-sense and respect for his pipe line alone would make him crack his valve and allow the steam to be wiredrawn. The period of time allowed for a balance of pressure to take place should be watched so as not to do this too suddenly. Under these conditions no danger can arise."

Were the above requirements strictly observed there should be no objection to cutting in boilers carrying any difference in pressure, however great. Common practice, however, limits the difference of pressure to a few pounds. And this is proper. The greater the difference in pressure the greater the danger to pipe lines from careless manipulation of the valves.

C. O. SANDSTROM.

Results of Friction in Steam Pipes

SATISFACTORY operation of apparatus used in power plants depends greatly upon the manner in which it is connected up.

An ejector connected as shown in Fig. 1 refused to operate when an engine, supplied with steam from the same line, was running. When the engine was stopped, however, the ejector would again operate.

This trouble was remedied by tapping the shell of the boiler on the side and running an independent pipe direct to the ejector, as shown by the dotted lines.

A similar case was that of a sight-feed lubricator connected to the steam supply pipe of an engine.

Figure 2, which illustrates the piping, shows a 1-in. line from the boiler terminating in a tee the 2 branches of which, also 1-in. pipe, connect to a steam pump and

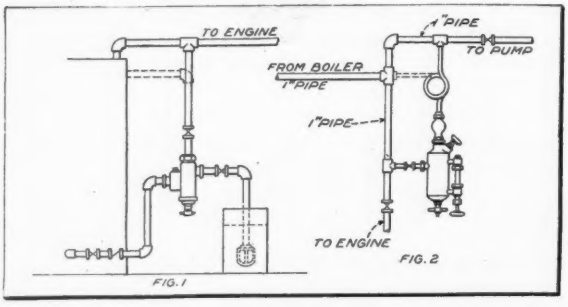


FIG. 1. EJECTOR CONNECTIONS WHICH RESULTED IN SATISFACTORY AND UNSATISFACTORY OPERATION

FIG. 2. FULL LINE CONNECTION CAUSED LUBRICATOR TO FEED BACKWARDS; DOTTED LINE CONNECTION RESULTED IN REMEDY

the engine respectively. Originally, the lubricator was connected to the 1-in. line leading to the pump; but it was found that whenever this pump was in operation, the lubricator would not work, but in fact would tend to reverse. It was then decided to change the steam connections as shown by the dotted lines in Fig. 2, after which the lubricator worked entirely satisfactorily, whether the pump was in operation or not.

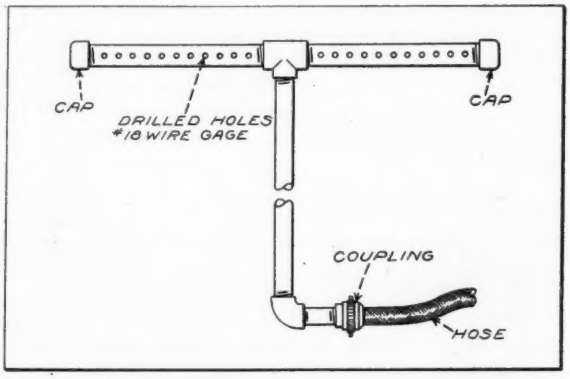
In both cases just cited, the trouble was brought about by frictional loss in the steam pipe. When the ejector was connected as shown by the full line connection, the friction brought into play by the use of the elbow was sufficient to result in a drop of pressure great enough to interfere with the operation of the ejector. The same may be said regarding the unsatisfactory working of the lubricator. Here again the reduced steam pressure brought about by the friction of the elbow was responsible for the failure of the lubricator to feed.

L. K.

Ash Spray

IN THE June 1 issue, page 551, is illustrated an ash spraying device to lay the dust before pulling the ashes out into the room. This is a good idea, and one that could be easily adopted in boilers; if, however, you have stationary grates, when you pull the ashes out of the firebox you will still fill the room with dust.

I have a homemade device to overcome this (see cut). The material needed consists of 2 pieces of 1-in. pipe 6 in. long with No. 18 holes drilled ½ in. apart and a cap on one end; the other end is then screwed into a tee



ASH SPRAYING DEVICE MADE OF PIPING AND FITTINGS

screwed onto a pipe 7 ft. long for a handle (longer if you wish) with an elbow on the end; now have a hose attachment and connect to the hose. To use this, turn water on as you wish, push the spray back and forth across the ashes on the grates until the dust is laid; this can also be used under the grates.

Some may object to putting water in the firebox, and, of course, in wetting the ashes one must be careful not to put water enough in to wet the grates too much; this may easily be adjusted. This device is being used by many engineers and is proving a success.

W. N. L.

Vacuum and Temperature Discussion

RELATIVE TO the discussion between A and B on page 641 of the July 1 issue, I wish to submit the following. I believe they are referring to jet condensers.

The temperature of the discharge of a condenser pump is not in any sense or degree a measure of the vacuum. The temperature difference of the supply water and discharge is a measure of the amount of steam condensed per pound of water and would be the same with no vacuum. The temperature of the steam in the exhaust pipe of the engine is a measure of the vacuum which would be perfect if there were no air leaks. Generally, however, air leaks are so slight when compared with the volume of steam that their effect may be ignored and the degree of vacuum obtained by noting the temperature of the steam in the exhaust pipe may be as close as that indicated by an ordinary vacuum gage.

HARRY D. EVERETT.

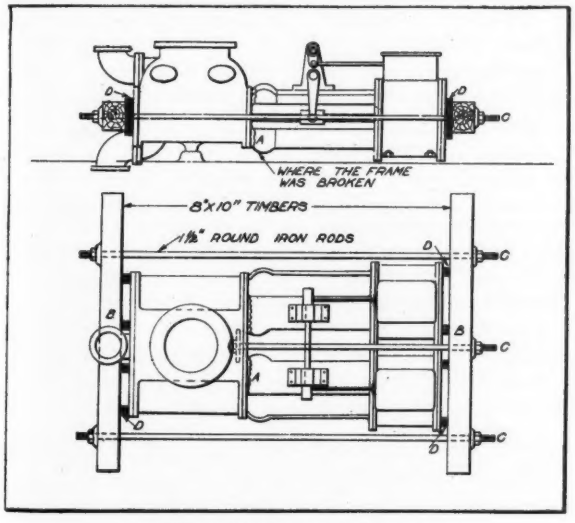
Successful Kinks From The Plant

For Saving Time, Work and Trouble

Pump Repair

AT ABOUT 1:00 a.m., one of our high-pressure pumps that drive the centrifugals broke the frame just behind the water cylinder head; for a while it looked rather serious as it was so close that it was not possible to put on a patch. We were driving the mills to their full capacity and the house was full and, as it generally happens in a sugar factory there is but little time to think of how you are going to make repairs, the rule is get going and think afterward how to make it better. The pump in question was steam-driven duplex, automatically regulated to maintain a pressure of 150 lb., but we had increased the pressure to 180 lb. to give more speed to the centrifugals.

First we got 2 heavy timbers about 8 ft. long and bored a 2-in. hole in each end, and in one we bored a



METHOD OF BRACING PUMP

hole in the center; we had already sent for the blacksmith and his helper and by the time we had the timbers ready he had arrived. He got out 3 1½-in. rods, long enough to reach the full length of the pump and timbers; these we threaded about 6 in. each end for nuts. Then we put one timber at each end of the pump and tightened up on the 2 outside rods; the one in the center we could not get through on account of a pipe that was in the way, so we made a large square washer of 1 by 4-in. iron to fit behind the flanges of the water cylinders, and after blocking in between the cylinder heads with hard wood blocks we started the pump slowly and kept tightening on the rods. Well, those hardwood blocks were as much good as rubber; so we took them out and put in iron, which held all right after we got the rods well tightened and it proved to be a very good job. We did, however, reduce the pressure to 150 lb.

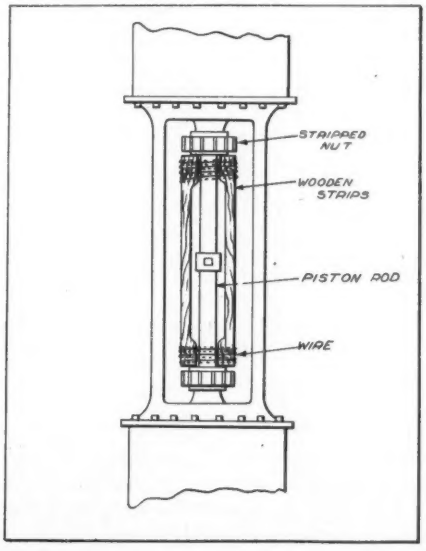
The next day, when the men came on, we reinforced the rigging some; but since it proved so good, we left it as it was. We got going in a very short time and did not delay the vacuum pans, as the other mixer was empty at the time the pump broke and the one set of centrifugals was able to keep up with the work.

It was not a very attractive looking job, but it did the work and the pump ran about 6 weeks in that condition without giving any further trouble.

Referring to the sketch, A shows where the break occurred, B 2 8 by 10-in. timbers, C, C, C, 3 1½-in. rods, and D, iron blocking. A. RUFNER.

Emergency Stuffing-box Repair

THE WRITER was recently on some repair work for a construction company, fixing up some hoisting machinery. A small water pump was used to drain a pit in which a considerable number of men were at work in evacuation. In connection with the pump one of the stuffing-box nuts stripped clear of the box and it was impossible to operate the pump at all to advantage. A



WOOD STRIPS TO HOLD STUFFING NUT IN PLACE

new stuffing-box would have incurred much delay as the pump was the only one at hand, and a machine shop was not near the pit by a good many miles. The sketch shows how the nut was held until work in the pit was completed nearly a week later when the pump was sent in. Small wooden strips were cut of a length to hold the loose nut tight against the water end packing nut which was the one stripped. The wooden strips were wired together around the piston and the pump worked very nicely. F. W. BENTLEY, JR.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Exciters and Excitation

REFERRING to the article on "Exciters and Excitation," page 585 of the June 15 issue, I would appreciate some information as to what advantage, if any, is gained as far as exciter speed is concerned, by having the exciter motor-driven?

Suppose the equipment consisted of an engine-driven direct-connected alternator, running at 150 r.p.m., and one exciter belted to the engine shaft and running at 900 r.p.m., the speed ratio being 1 to 6. Now, if a load, sufficiently heavy to reduce the speed temporarily, say 5 r.p.m., strikes the engine, the exciter-speed will have been reduced 5 times 6 or 30 r.p.m., or its speed is now 870 r.p.m.

Suppose further that the alternator has 48 poles and the frequency, therefore, at full speed, is 60 cycles per second. At the reduced speed of 145 r.p.m., the frequency would be equal to the product of the number of pairs of pole times the speed in revolutions per minute divided by 60, or 24 times 145 divided by 60, or 58 cycles per second. Now suppose this exciter to be directly connected to an induction motor having 8 poles and running at 900 r.p.m. neglecting the slip. If this motor alternator was driven by current from the above alternator its speed at the reduced alternator speed of 145 r.p.m. would be equal to the product of 2 times 58 divided by 8, times 60, or 870 r.p.m., which is the same as that in the first case. If the above is correct, it would appear that the speed variation would be the same whether the exciter is motor-driven or belted from the engine shaft. K. W. K.

A. As far as speed regulation is concerned, the exciter which is direct-connected will be equal or superior to the motor-driven unit. If the increase of load mentioned is not attended with an increase of exciter load, then the exciter speed will be the same, whether the exciter be direct-connected or motor-driven. If the increase in alternator load is attended with an increase of exciter load because of automatic or hand regulation, then the direct-driven exciter will show the better speed regulation since the increase in exciter load causes increased slip in the motor. You have dealt with synchronous speed only, whereas motor slip may enter to cause further decrease in motor speed provided, of course, the separate units are induction motor-driven.

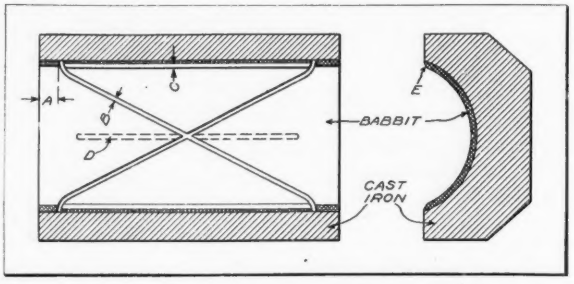
Motor generators for excitation purposes are usually compounded by noting the no-load voltage at synchronous speed and taking the full-load voltage at full-load motor speed. If this is done, then the effect of slip in the motor generator is counteracted though the slip itself remains. This does not, of course, make up for engine regulation.

You qualify your question by saying "as far as speed is concerned." In the matter of speed, the direct-connected exciter is equal to the motor-driven unit. The advantages of the latter lie along the other lines suggested. It should be noted that in the article referred to, the statement reads substantially that the speed regulation of a direct-connected exciter is inferior to an independently driven unit. A motor generator depends upon the alternator and is, of course, not independently driven. An independent unit requires its own prime mover. GORDON FOX.

Bearing Troubles

I HAVE charge of an 11½ by 20-in. engine which heats in the main bearing. I have used graphite and valve oil, but with poor results. The shaft is smooth and there is plenty of babbit in the boxes. W. W.

A. There is a cause for every effect. It is but a question of analyzing the difficulty and either directly, or by the process of elimination, arriving at what seems to be the proper remedy. Although many engines are operating with complete satisfaction without the sign of an oil groove in the bearings, and a few eminent engineers



PLAN AND SECTIONAL VIEW OF THE BOTTOM SHELL OF A 4-PIECE BEARING

are opposed to them, it is good practice that ought to be followed as a general rule to provide ample oil grooves in the bearings of a size and design that will provide ample lubrication at all times.

In the accompanying illustration is shown the design of grooves that were used by the writer on both new and repair work on bearings 48 in. long for a 24-in. shaft, and from that on down to a bearing for a 10-hp. engine.

The sketch shows the bottom shell of a 4-piece bearing, both plan and section at the point where the grooves cross. The revolving shaft will work the lubricant towards the center of the bearing and then toward the end again, where the process will be repeated on the quarter boxes.

An inclined groove like this will insure better lubrication than any other method that has been tried, and there have been many. It insures ample lubricant at the center of the bearing, which is the all-important thing. The excess will work out at the ends of the bearing; but if oiled at the ends with any other method of grooving, or no grooves at all, it is difficult to make the oil work toward the center of the shaft. This will reduce the lubricant at that point, cause a rise in temperature which increases the diameter of the shaft, increases the friction and reduces the thickness of the film of oil; the result is a hot box.

The distance at A, should not be over 1 in. in the largest bearings nor less than ½ in. in any bearing for best results, and all shells should be laid out accurately so that the oil will work freely from one shell to the next in the line of rotation.

Quarter boxes should be laid out the same as the bottom shell, and whatever the design of the top shell, the grooves should be such as to lead the oil into the grooves at an angle. These grooves should be fully ⅜ in. wide, as at B, on the largest bearings, and not less than 3/16 in. on any bearing, and should range from ¼ to ⅛ in. deep, depending on the size of the bearing.

Anneal a small coarse round file, curve the point and temper it again, and with this make the grooves as smooth as possible. Scrape the burrs off and incline the sides a little. As indicated at C and E, bevel the babbit between the ends of the 2 grooves to a width of at least ½ in., as shown at C. For bearings of exceptional width such as the bottom shell of a 2-piece bearing on a vertical engine, add a generous groove D as shown by the dotted line, letting it come within perhaps 2 in. from the end of the bottom shell.

There is such a thing as clogging the oil grooves with graphite, thus retarding or entirely stopping the proper distribution of the lubricant. Look well to the alinement of the shaft. Is the tension of the belt excessive? This has been the cause of numerous hot bearings.

As an antidote for a bearing that normally runs cool, but becomes heated from stoppage of the lubricant, or some foreign matter falling in, take good sulphur, pulverize it well, mix with castor oil, using about 3 lb. to the gallon, and feed gradually through the handhole (if there is one) or otherwise through the oil cup holes after removing the cups.

A shaft may become so polished and "dead smooth" that it will not take the oil. The remedy for this is to take brick sapolio and powder it to a dust, mix with water and feed gradually with the engine running slowly and under complete control.

When satisfied with the finish on the shaft, stop the mixture and follow up generously with kerosene, and gradually work in the regular engine oil.

Sometimes after several years of satisfactory service, engine bearings will begin to behave badly, especially in the main bearings. In an instance like this, one of 2 things will usually be found as the cause: either the babbit has worn to a feather edge on the quarter boxes and broken off, thus wedging somewhere and causing excessive friction, or the babbit has become crystallized and broken up into small pieces from constant operation. Chip off and scrape for the first; for the second, the only remedy is rebabbiting. G. H. WALLACE.

Evaporation Produces Temperature Drop

WHY IS air in motion cooler than that not in motion?

Will a thermometer register any higher if held 6 in. above a volume of cold water on a hot, clear summer day than if held the same distance above a quantity of sheet iron? Why?

Is it possible for the sun to make a piece of sheet iron hotter than the actual heat produced by the sun which is shown by the thermometer if held near the iron?

J. W. D.

A. Air is no cooler when in motion than when not; but air in motion will carry away moisture from stationary objects, and the evaporation of this moisture is what produces the drop in temperature.

Take 2 thermometers in a room where there is practically no movement of air. Surround one of these with a wet cloth, and leave the other one dry. The one with the wet cloth on it will show a considerably lower temperature than the dry bulb, depending on the percentage of saturation of the air. When the air is in motion, this evaporation is more pronounced, and the difference between the temperatures of the dry bulb and the wet bulb thermometers will be increased.

With a thermometer held 6 in. above a volume of cold water, on a hot day, it would unquestionably show lower temperature than if it were held a distance from the water. There will be a cool vapor rising from the water, which will lower the temperature at that point. Further, there will be a movement of air across the surface of the water, due to the fact that there is a cold layer there, and this movement of air across the thermometer bulb will tend to produce the lowering of temperature already mentioned.

Your third question is one which your own experience will answer. You know that if you stand on the south side of a brick or stone building, on a hot day, when there is little air stirring, the building wall will be considerably hotter to your hand than the air a little distance away. This is for 2 reasons:—First, the wall reflects heat, thus creating an accumulation of heat near its own surface. Second, it absorbs heat and piles it up in its own substance, thus accumulating a heat greater than that of the air nearby.

Of course, the wall does not become any hotter than the heat which is given to it by the sun's rays; but the air near the wall is tempered by the motion, which is always taking place to a considerable extent, even when we think there is a dead calm, and the heat is reflected and radiated and conducted to the hand by the wall, or by a piece of iron, much more quickly and perfectly than by the air near the solid substance. A. L. R.

Converting Air Compressor into Dry Vacuum Pump

WOULD IT be possible to use an Ingersoll-Rand air compressor as a dry vacuum pump?

This compressor has Hurricane inlet valves and poppet discharge valves, is 2-stage and delivers air at 110 lb. pressure. I would like to know whether I could use it as a dry vacuum pump by piping the suction to condensers and discharging to atmosphere. F. B.

A. We see no reason why your air compressor would not serve as a dry vacuum pump. The economy will

not be very good, since your ratio of steam to pump cylinders is designed to take care of a compression from atmosphere up to 110. The ratio would be 15 to 125, or about 8.35.

If you are pulling a 28-in. vacuum in your condenser, the ratio here will be about 1 to 16, or 16, since you will hardly discharge at less than one pound gage. At 26 in., your ratio would be 2 to 16, or about 8, and under these conditions, the compressor should work very well.

Probably your compressor capacity would be much larger than you would need, but if you are working with a high vacuum—27 in. or over—you will likely find some difficulty in getting the compressor to discharge, since the ratio of compression is not high enough.

A. L. R.

Distortion of Engine Valves

Is it possible for the steam valves on a Corliss engine to warp so that they leak? I am working at a plant where we have a new Corliss engine and have trouble with one of the steam valves. It will rub and groan as if it could hardly run. Oil does not help it. We wrote to the maker of this engine, and the question quoted above is the answer we received. I would like to know what you think of this. W. A. P.

A. Yes, it is possible for steam valves not only to warp and leak, but to warp and leak so much as to interfere seriously with the profits. In fact, one is safe in saying that practically every engine has had the same trouble when new, and if it disappears with time, it is in direct proportion to the extent of the deflection of the valve due to the change of temperature.

While engine builders are aware of the fact that valves do warp (and indeed, this one thing is the stumbling block of every steam engine builder and designer), yet they do not know the great extent to which this defect exists, for the reason that it is seldom observed even by those in charge, and still more seldom brought to the attention of the builders.

The fact that you received from the builders of your engine, in reply to your quest for information, the inquiry which prompted this reply, is evidence that they so far scout the idea of warping of valves as to consider it preposterous, if not impossible.

There are many concerns building engines of the 4-valve, semi-rotary type, whether the valve gear be of the releasing or the nonreleasing type. Then add to this the several different types of valves for positive motion compressors, pumps, etc., and one has but a faint idea of the vast number of different designs of this type of valves.

The oldfashioned Corliss engine was slow and deliberate of speed, and had single-ported valves. These were, in substance, 2 round disks (usually partly relieved at the top) which filled the end of the ports outside the opening into the cylinder, connected by a bar shaped something like the letter "A" in section. This was cast in one piece, of course, and machined to size to fit the steam port, which it did, cold. Some builders scraped the valves to an absolute fit, cold, and considered their duty done. Others stopped at a finishing cut over valve and through port, and chipping the edge of valve and port to give a definite place of action when the valve was in operation, while still others did not, and even yet do not, chip or mill the valves or ports for this purpose, but leave these parts just as they come from the foundry, boring the port and turning the valve to fit, letting it go at that.

But when you stop to examine the design of this valve, you can readily see that the top of the letter "A" part of the valve, will get hotter than the remainder of it, owing to the fact that it is constantly exposed to steam at or nearly boiler pressure, while the ends of the valve come in contact with the comparatively cool exterior of the cylinder, and the bottom part of the rib which covers the port is alternately subjected to the cooling influences of the exhaust steam during half of the stroke.

In fact, if you will examine the tracing of an indicator card, you will note that as soon as cutoff takes place, say, for instance, at 25 per cent of the stroke, the pressure in the cylinder falls as traced by the expansion line, and this reduction of steam pressure in the cylinder is accompanied by a corresponding decrease in temperature, while that part of the valve still exposed to the steam in the chest, which is at or nearly boiler pressure, is under an influence of greater temperature, and being so, will expand.

This being the case, the valve will ride at both ends, leaving the middle portion of the valve free from contact with the seat. This distance may vary all the way from 0.0015 to 0.015 in. and is, of course, greater in the valves of large cylinders than of small ones, although the writer has found as much as 0.010 in. clearance between the valve and seat of a valve in a 12-in. Corliss cylinder. This, however, was a rare exception, and was possibly caused by an improper mixture of the metal, and the method of casting and cooling it.

It is the custom, when making large low-pressure cylinders of triple-expansion engines, such as crank-and-flywheel direct acting pumps, which have Corliss inlet valves and poppet exhaust valves located in the heads, to file or scrape the steam valves especially, to a fit at the temperature at which they operate.

Generally, the initial pressure in the low-pressure cylinder does not exceed 2 or 3 lb. gage and it is not a difficult matter to arrange for a temperature equal to this pressure when scraping the valves in place.

In fitting the valves on a 94-inch cylinder with single ported valves in the heads, the writer had an opportunity to observe abnormal distortion of a valve which was about 9 in. in diameter and approximately 9 ft. long.

This valve was machined an accurate fit, cold, and scraped to fit, when it was suggested that it be subjected to a steam pressure of 3 lb. and the distortion noted. This was done by blocking the openings and connecting the steam to the chest at the desired pressure for a few hours. Hastily removing the valve and placing it on a large surface plate, it was found that the valve rose off the plate in the center a little more than 1/16 in.; as soon as it cooled off, it returned to normal position.

The difficulties that have attended the designing of a large flat gridiron valve for some types of engines have been many, and it is almost impossible to make a flat valve that will not leak under even a narrow range

of pressure and temperature. The only remedy is to examine frequently and file and scrape down the bright spots, which will gradually work out all the black spots where leakage occurs, and also the polished ones where excessive friction occurs, and leave the valves a bright, smooth surface all over. Use good oil and keep the steam at as near a constant pressure as possible consistent with the range of load, and with care and judgment you can bring the valves to an almost perfect condition.

G. H. WALLACE.

Refrigerator Flooring

I WOULD like to know what is the cheapest installation for an icebox floor where room is precious.

D. E.

A. About the cheapest floor which will be found satisfactory, so far as loss of ice is concerned, would be made as follows—this is assuming that it is a floor above another room:

One-inch tongued and grooved boarding, 3 layers of insulating paper, 1-in. tongued and grooved boarding. Two-by-9 joists, spaced on centers so as to be sufficient to carry the load. This will depend, of course, on the length of span, and the weight to be carried by the floor.

The spaces between the joists should be filled in with silicate cotton or cork. On top of the joists, lay 1-in. tongued and grooved boarding, 3 layers of insulating paper, and a top floor of 1-in. tongued and grooved boarding.

A. L. R.

Angle of Advance

HOW WOULD a draftsman proceed to show the angle of advance of an eccentric? J. W.

A. Angle of advance is equal to 90 deg. plus lap plus lead.

Draw a circle to represent the crank circle, with a radius equal to the actual radius of the eccentric. Place crank in position and from that measure off 90 deg., then add on the circumference a distance equal to lap plus lead, and you will have the position of the eccentric, which may be shown to scale in a smaller circle.

G. A. T.

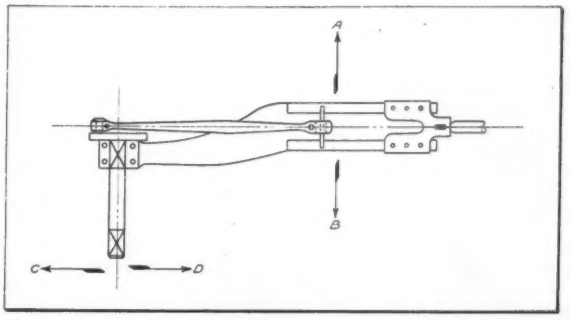
Proper Alinement of Crankpin

IN THE June 1 issue, J. W. W. asks how to determine whether the crankpin is parallel with the crankshaft, and G. H. Wallace gives a method which, I cannot admit, covers the question in full.

As long as the connecting rod always moves through the plane of the centerline of the cylinder, an ideal condition exists. It is possible for a crankpin to be "cocked" askew a measurable amount, yet in nowise be detrimental to proper work.

Referring to the accompanying figure, let us assume having removed our wristpin and pushed the crosshead back toward the cylinder as far as possible. The crank is on dead center, the crankpin being at the farthest possible distance from the cylinder. I shall call this position "outer center," and the opposite dead center "inner center." Place the end of a broomstick through the wristpin brasses as shown, each end of this stick resting one of the crosshead ways, four preventing the connecting rod end from falling while turning the crank. Now, with the crank on the outer center, push the loose rod end sidewise, in the direction of arrow A, and then the opposite way, in direction B. Measure the amount of motion possible each way, and note whether the central point of this motion coincides with the centerline of cylinder, as measured from the sides of the crosshead ways. Now turn the crank to the inner center and repeat. Next place the crank at the highest point (half stroke), and repeat; then with the crank at the lowest point. Now, having examined the behavior of the loose rod end in 4 positions, we have learned several things. If at both inner and outer centers, and at both the highest and lowest points of the crank, the rod end had an equal lateral motion to each side of the centerline of cylinder, the crankpin is parallel with the shaft and the shaft square with the cylinder.

If the rod end had more motion toward A than B at both centers, then the outboard bearing is too near the



SIMPLE METHOD OF DETERMINING CRANKPIN ALINEMENT

cylinder, and should be moved in direction C, to bring the crankshaft square with cylinder. If the rod end moved more toward A than B at the outer center, and more towards B than A at the inner center, then the point of the crankpin is cocked away from the cylinder when the crank is at the outer center.

If the rod end moved more toward A than B at the upper position of the crank, and more toward B than A at the lower position of the crank, then the point of the crankpin is cocked away from the cylinder when the crank is in the upper position.

This method of using the connecting rod to indicate what is wrong, and how much it is wrong, is useful both when erecting an engine and when overhauling it. It shows the faults I have mentioned, and, most important of all, shows whether the fault is or is not great enough to be worth while correcting.

H. K. SCHOLEFELD.

WHEN SOME ¾ by 1½-in. soft rubber washers were needed and only ¾ by 1⅛-in. were in stock, W. S. Doan in Refrigerating World tells how he overcame the difficulty. Washers were made from sheet packing 1⅛ by 1½ in. and somewhat thinner than those of rubber to hold the latter in place. The packing washers were placed around the outside of the rubber washers, and screwing up the gland, compressed the rubber, stretched the packing and made all tight.

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Control Equipment Development

With the great and notable strides made in the design and construction of higher capacity and more efficient power plant generating equipment, comes the introduction of apparatus insuring a more positive control of the higher voltages and larger currents handled, the installation of devices protecting the generating units from possible damage by overloads caused by short circuits or otherwise, and the employment of safeguards insuring continuity of service.

In the early days of electric power plants, the belt-driven units were connected to the bus bars by open wiring carried in any fashion and direction that convenience and inclination dictated, regardless of any possible attendant danger or interruption of operation. All switching for the control of machines and distribution circuits was done by open, manually-operated knife switches mounted on the front of wooden switchboards, in many cases designed more as ornaments than useful pieces of equipment. The only protection afforded the generators was that given by unreliable lightning arresters, unresponsive circuit breakers and open link fuses always more of a source of danger to the operators and the station equipment than a protection.

Present day designers, however, specify that all conductors be carried in conduit, which may range from the small solid or flexible tubing for those lines carrying small currents at a low potential, to the modern cable trench made of brick or concrete and containing shelves upon which the heavy conductors rest, and of such dimensions as to permit repair work being carried on within the trench and without danger or inconvenience to the workman. Risers are usually placed in vitrified clay ducts, well anchored within brick "chimneys."

In spite of the fact that the old modern switchboard was cheaper in first cost and could readily be erected by anyone able to handle a saw and hammer, the greater safety to life and property, and the elimination of possible service interruption brought about by the use of the modern masonry bus structure containing the large securely mounted and insulated bus bars, disconnecting switches and electrically operated remote controlled oil switches, many times compensates for the additional expense involved. The modern bench board with its master switches controlling the remotely operated oil switches and electrically operated field rheostats has not only made the work of the switchboard attendant safe but has given him considerably greater and more positive control over the operation of the electrical end of the plant.

On account of the poorly constructed distribution lines of the early days, short circuits were of frequent occurrence, and a source of considerable uneasiness for the operator, for with every circuit breaker failure, such short circuits would be thrown directly on the machine, which under the accompanying excessive loads would drop its voltage, resulting in a disturbance over the entire system. With the employment of current limiting reactances, conditions have, however, changed for the better, so that today a short circuited distribution circuit will many times exist unnoticed.

Not only has it been found advisable to insert these reactances into the feeder circuits where they leave the

plant, but in order to eliminate any possible interruption, or even disturbance, these coils are placed between sections of the bus bars, in generator leads, and, in fact, in many plants, current limiting reactance may be found connected in the leads of some of the heavier motor-driven auxiliary apparatus.

News Notes

THE PENNSYLVANIA STATE COLLEGE will conduct a Summer School of Scientific Management during the 2 weeks beginning Aug. 9. This summer session is planned for the accommodation of works managers, superintendents, heads of cost, stores, purchasing, planning and production departments and members of such departments. The time is restricted to 2 weeks to meet the needs of employes whose vacation period is limited to that time.

Mornings of the session will be devoted to lectures and discussions on industrial organization and scientific management under the leadership of Professor Hugo Diemer, head of the Department of Industrial Engineering at the Pennsylvania State College. Professor Diemer has had charge of summer courses in the Industrial Organization and Scientific Management at the University of Chicago this summer. He has been superintendent of the National Motor Vehicle Co., organizing engineer for the Goodman Mfg. Co. and has done advisory work in planning shops, organization, cost, stores, wage and production methods for such companies as Fairbanks Morse Electric Co., the Western Gas Construction Co., the Cincinnati Milling Machine Co., Atlas Engine Works, International Harvester Works, Bullock Electric Co., Marion Iron and Brass Bed Co. and others. He has written several books and numerous magazine articles on organization and management.

Afternoons will be devoted to actual practice in applied methods of Scientific Management, in the making of time studies, tool lists, instruction cards, routing and scheduling under the direction of W. H. Tabor. Mr. Tabor's experience at the plant of the Tabor Mfg. Co. enables him to demonstrate the methods used in what has been designated as the most completely developed shop under scientific management in America. The shops of the Pennsylvania State College have been especially provided with means for teaching and demonstrating applied methods of Scientific Management. State College is a favorite mountain summer resort and the course affords an opportunity to combine a pleasant outing with the acquisition of valuable knowledge. The fee for the course is $15. Applications should be made at once to J. A. Moyer, director, State College, Pa.

THE WESTERN KIELEY Steam Specialty Co. announces that injunction was issued on June 23, 1915, by the Circuit Court of Cook County, Ill., enjoining other firms from using the name "Kieley Specialty Co." or other name including "Kieley" and the word "Specialty" in any combination or manner whatsoever.

DUE TO the increasing demand for Engberg direct connected generating sets, searchlights and electro-hydraulic valves, Engberg's Electric & Mechanical Wks., St. Joseph, Mich., has found it necessary to establish an office at 39 Cortlandt St., New York.

EDWIN M. HERR, President of the Westinghouse Electric and Manufacturing Co., received the honorary degree of Master of Arts from Yale at the 215th commencement, Wednesday, June 23.

Mr. Herr was born at Lancaster, Pa., May 3, 1860, and began his career as a telegraph messenger and then as an operator in Denver, Colo., later becoming station master and operator at Deer Trail, on the Union Pacific Railway. While in this service he prepared for college, graduating as a mechanical and electrical engineer from the Sheffield Scientific School of Yale University in the class of 1884. After graduation he became a special apprentice of the C. M. & St. P. R. R. in the motive-power department at West Milwaukee, and later entered the motive power department of the Chicago, Burlington & Quincy Railroad as mechanical draftsman and test engineer. Owing to his former experience he was finally made superintendent of telegraphs of the C. B. & Q. system, and his work in this department brought him to the attention of the operating depart-

ment and led to his appointment as division superintendent of the Galesburg Division of the line. In 1890 he went with the C. M. & St. P. R. R. as master mechanic, which position he held until 1892, when he was called to the superintendency of the Grant Locomotive Works at Chicago. In 1895 he was sent to Europe by financial interests to report upon and establish locomotive works in Russia, upon the completion of which mission he became, in 1896, general manager of the Gibbs Electric Co., of Milwaukee, and shortly after accepted the position of assistant superintendent of the motive power department of the C. & N. W. R. R. In 1897, he went to St. Paul as superintendent of the motive power department of the N. P. R. R., which position he retained until 1899, when he went to Pittsburgh to take the position of assistant general manager of the Westinghouse Air Brake Co., later becoming general manager of that company. In 1905, he was appointed first vice-president of the Westinghouse Electric & Manufacturing Co., which position he occupied until his election as president in 1911.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Lagonda Mfg. Co., at the Pan.-Pac. Ex.

AMONG the interesting exhibits at the Panama-Pacific Exposition is that of the Lagonda Mfg. Co., of Springfield, Ohio. This consists of a display and illustration of the operation of its boiler tube cleaners, automatic cutoff valves, multiple strainers, and grease extractors.

As seen in the illustration of the exhibit, to the left are the high-power direct motor-driven tube cleaners for boilers, condensers and economizers, suspended and inserted in condenser tubes and the tubes of a B. & W. manifold, as they are in actual use. Directly behind these cleaners can be seen the handwheels of the types A and B outside and internal dashpot automatic cutoff valves, and the Type C or internal dashpot nonreturn valve.

At the back of the exhibit and to the extreme left is an interesting exhibit of the Lagonda Stirling boiler cleaning device by which the entire operation of cleaning is from without the drum. The device is supported in an oval frame, representing the manhole, and has the cleaner and rubber operating hose inserted, as in operation. Immediately to the right of this and to the left of the booth are shown the electric and air or steam motor driven reseating machines, for reseating and grinding fitting surfaces and cleaning scale and soot from caps and nuts of B. & W. and similar type boilers.

To the right of the entrance of the exhibit is a stand containing a full display of all types of water, air and steam turbine driven cleaners for water and fire-tube boilers, condensers and other tubular apparatus, also cleaners for curved tube boilers.

On a second stand directly behind the turbine cleaners are exhibited Lagonda Tube Cutters and a sectional model of the Type A automatic cutoff valve, showing

BOOTH AND EXHIBIT OF THE PRODUCTS OF THE LAGONDA MFG. CO.

the construction and operation of the valve and external dashpot. Directly behind this is the new Lagonda grease extractor and a 3-basket multiple strainer. The grease extractor is of a new and interesting design, operating on the principle of the Lagonda multiple-basket water strainer.

The demonstration of the working of the multiple strainer is especially interesting. A 3-basket type strainer has been constructed with a glass panel at the end, so that the flow of water through the strainer and the accumulation of solid matter in the basket can be seen. In operation a small 2-basket strainer body at the left is used for inserting sticks, leaves and other such refuse as is found in plant supply water; then the water is turned on and allowed to flow through the strainer. All the solid matter passing into the strainer is caught in the strainer baskets. It is then demonstrated how the strainer baskets can be individually drawn out of commission, removed and cleaned without interrupting the operation of the other baskets or the flow of water.

The back wall and booth of the exhibit are finished in oak, and equipped with rug, desk, easy chairs and drinking water for the comfort of visitors, who are welcomed by members of the Lagonda Co., and Chas. C. Moore & Co., engineers, who have charge of the exhibit and are the western representatives of the Lagonda Co.

Improvements in Hoppes Meter

SINCE the first Hoppes V-notch feed water meters were put on the market by the Hoppes Mfg. Co., a description of which appeared in the May 1, 1914, issue, some important changes have been made in details which allow more liberty in the location and permit easier adjustments as well as overcoming the effects of vibration of the meter support on the recorder.

This meter operates on the V-notch principle, the flow of the water over the weir being indicated and recorded on a revolving chart, the position of the pen being controlled by the head of water above the weir. This is accomplished by suspending a vessel of proper shape by a coil spring and providing a flexible water connection between the vessel and the water chamber back of the weir. An indicating rod attached to the vessel shows that the vessel lowers as the head above the weir rises; this deflection is in direct proportion to the flow of the water and is so recorded on the chart. The integrating wheel moves in unison with the recording pen and is kept in contact with the back of the revolving disc, thus its speed is proportional to the flow of water over the weir.

FIG. 3. HOPPES INTEGRATING AND RECORDING V-NOTCH METERS

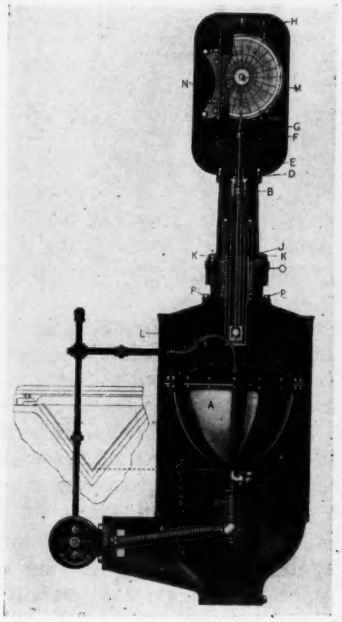


FIG. 1. INTERIOR CONSTRUCTION, SHOWING IMPROVEMENTS IN HOPPES V-NOTCH METER

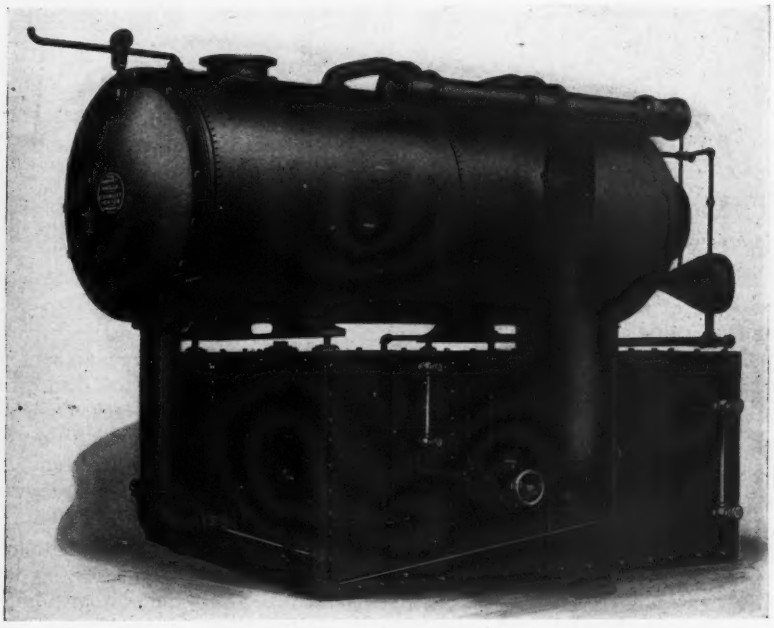


FIG. 2. HOPPES METER AS APPLIED TO HEATER

One of the recent improvements was to make the guide in the recording head longer and heavier. This improvement has overcome the effect upon the pen record and integrator of vibrations, which are considerable in many plants.

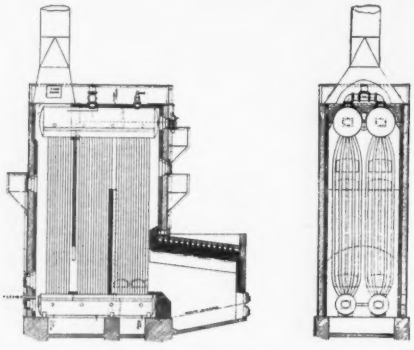
Adjustment of the apparatus has been simplified by locating the band O at the bottom of the column which obviates the necessity of changing the brass sleeve E when adjusting the instrument to the zero level. Adjustment may now be made by simply loosening the screws K and turning the band O up or down until the water drops slowly from the pet cock C. The apparatus is then ready for operation, as all other adjustments are made at the factory.

An improvement has also been made in the recorder head which makes it possible to locate it either above or below the weighing cabinet. Where it is desired to place the tank on an elevation above the floor an inverted recorder head is supplied which brings the dial down to a convenient height, making it easy for the operator to read and change charts.

Morrison Boiler

ACCOMPANYING views will give our readers a good idea of the Morrison boiler.

The Morrison boiler, it will be noted, consists essentially of vertical tube sections placed together so as to offer uniform alleyways throughout for travel of gases from front to rear, the furnace or dutch oven being placed at the end of the drums in order to secure unimpeded circulation.



SIDE AND FRONT SECTIONAL VIEWS OF MORRISON BOILER

The baffle construction is unusually durable, being composed of 9-in. walls which support themselves independently of the tubes.

This boiler is made by The Morrison Boiler Co., Sharon, Pa.

BENEFITS GAINED from the use of flow meters in one plant are stated by those in charge as increase of plant efficiency by 5.5 to 14 per cent; keeping check on operating conditions; balancing load between plants to best advantage; determining when and how often flues should be blown.

AN OIL ENGINE that in Chicago, St. Louis or New York had produced 75 hp. could do no better than 40 hp. in South America, where the altitude was 11,000 to 13,000 ft. above sea level.

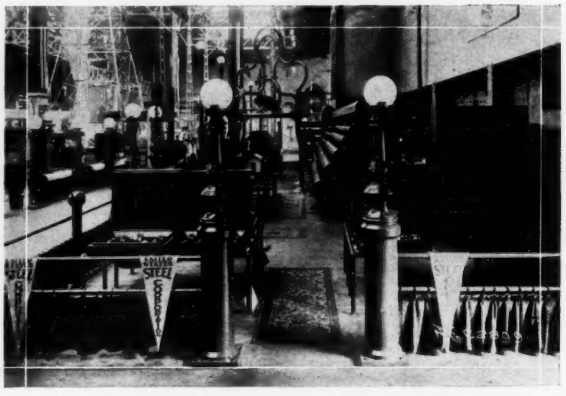
National Tube Co., at Panama Pacific Exposition

THE exhibit of the United States Steel Corporation is located in the southern end of the Palace of Mines and Metallurgy, occupying a total floor area of more than 45,000 sq. ft. and covering practically all the activities and products of the entire corporation.

Intricate models, large mechanical devices and practically every important step in the manufacture of steel products—from the mining of the iron ore in the Lake Superior district, to the finishing of the completed material in the steel mills of Pittsburgh, Pa.; Lorain, Ohio; or Gary, Ind.

More than 6 miles of motion picture film give the visitor a realistic story of the operations required to convert the reddish iron ore into finished products.

Much human interest is to be found in the welfare and safety pictures, of which there are nearly 3000 ft. Playground scenes show thousands of youngsters in playgrounds maintained by the U. S. Steel Corporation for the benefit of the children of its employes.



NATIONAL TUBE CO.'S EXHIBIT

It would be manifestly impossible to describe all the individual subsidiary company exhibits, but a representative idea may be obtained through a description of that of the National Tube Co., which occupies an area of approximately 6000 sq. ft. This company manufactures 3 closely-related lines of products: National Pipe and Tubular Products; Kewanee specialties; Shelby Seamless Tubing.

Entering the main section, the visitor walks through a large arch, 15 ft. in height, made of miscellaneous bends of 4-in. pipe. Immediately behind this is a massive rack, on which are displayed the various types of National pipe used in the oil fields of the world, with the largest and longest individual length of lap-welded wrought-pipe ever made in America, consisting of one length of 20-in. O. D. pipe, 39 ft. 6 in. long.

The right-hand portion of the main booth is devoted to the display of Kewanee Specialties, including the union, regrinding valve, brass fittings, cocks and valves, malleable and cast-iron and wrought fittings. Probably the most commanding feature of this section is the colossal model, made to exact proportions, of a 2-in.

octagon union, with an eighth section cut from one side of the model in order to show in cross section the patented principle.

Across the aisle from the Kewanee section, in a separate booth, is the exhibit of Shelby tubing and cylinders. Perhaps the most unique feature of this exhibit is a set of furniture, consisting of 6 chairs, one settle, and a table, made entirely of seamless tubing. The method of manufacturing seamless tubing from a square, flat plate—known as the cupping process—is clearly explained in an exhibit which shows the various steps from flat to finished cylinders or tubes.

Oil Knife Switches

AN extension line of oil switches, Type D, for voltages up to 7500, has recently been announced by the Westinghouse Electric & Mfg. Co. These switches are non-automatic and are suited for a wide range of application, being made for indoor service in switchboard-mounting, direct wall-mounting, and remote-control wall or pipe-mounting styles; and for outdoor service, pole or subway mounting.

The direct wall-mounting style is particularly adaptable to motor installations on account of the facility with which it may be mounted on any support convenient to the motor operator. The lever and handle extend outward over the oil tank so that the switch may readily be mounted against a wall, post or any vertical support.

The remote-control wall or pipe-mounting style allows switch to be mounted at a convenient point away from switchboard and operated from the switchboard or other point as desired.

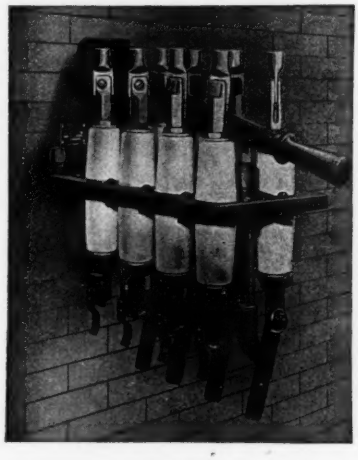


FIG. 1. INDOOR SWITCH FOR WALL MOUNTING, 300-AMP., 7500-V., 4-POLE, SINGLE-THROW (TANK REMOVED)

The outdoor type D oil switch, is particularly adapted for controlling lines where they enter buildings, branch feeders from the main lines, sectionalizing feeders, or any of the numerous purposes for which an outdoor type of switch may be utilized on distribution systems.

The subway-type oil switch is for mounting in subways, manholes and other places where a switch may be required to be operated submerged. The subway-type oil switch is made in 2, 3, or 4-pole single and double-throw for voltages up to 4500 and capacities up to 200 amp.

Characteristic features of this switch are: Knife blade contacts submerged in oil; live parts carried on insulating supports affording a high quality of permanent insulation between adjacent poles, and between the frame and live parts; small space required for mounting; accessibility of parts for purpose of inspection and repair; enclosure of all live metal parts; and low first cost.

Knife blade contacts are used, as they insure the best contact for low temperature rise in a non-automatic switch. Each contact jaw has attached to it an arcing piece which takes the final break, thus preventing any burning of jaws. These arcing pieces are inexpensive and readily replaced when worn or burnt away.

With the exception of the 1500-v. switches, the contacts are mounted on all-porcelain insulation. In switches for 7500 v. and above, the insulation is of the pillar porcelain type, similar to that of the best accepted

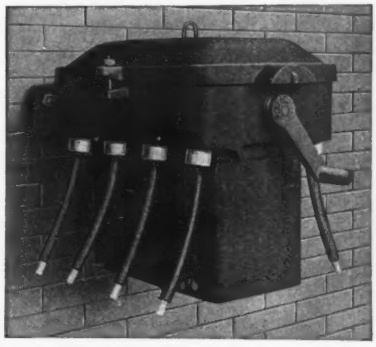


FIG. 2. OUTDOOR SWITCH FOR WALL OR POLE MOUNTING, 4500-V., 200-AMP., 4-POLE, SINGLE THROW

standard form of circuit-breaker construction. In the 4500-v. type up to 200 amp. the contacts are mounted on a sturdy horizontal porcelain base, with molded porcelain barriers between all live parts. In general, this form of construction gives these switches the same characteristics ordinarily looked for only in the highest grade oil circuit-breaker construction.

The type D switches generally provide a line only paralleled by the non-automatic form of oil circuit-breakers, but by being designed particularly as switches not intended to be used automatically, they combine within their limits of capacity and voltage the highest grade of construction, insulation, etc., with a more moderate price than could apply to the non-automatic form of oil circuit-breaker.

RALPH T. COE, Manager of the Canadian Sirocco Co., Ltd., Windsor, since the organization of the company, has resigned to enter the engineering service and sales field in New York State. Mr. Coe has been appointed District Manager for Warren, Webster & Co., and the American Blower Co., and will have offices at 519 Insurance Bldg., Rochester, and 19 Live Stock Exchange Bldg., Buffalo.

The Tool-Om-Eter

AN instrument whose chief application is the measurement of air for various pneumatic tools has recently been developed by the New Jersey Meter Co., of Plainfield, N. J., and is called the Tool-om-eter. This instrument shows direct on a scale, in cubic feet of free air per minute, the flow of air in the pipe or hose.

The principle upon which it operates is the law that the volume of a definite compressed fluid or gas flowing under small constant head through multiple orifices of the same shape and size is directly proportional to the number of orifices exposed to the flow.

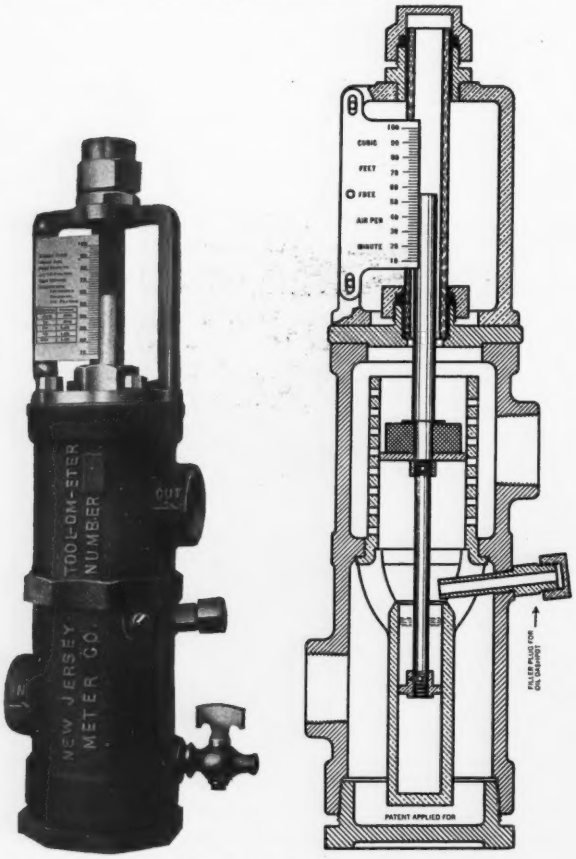


FIG. 1. EXTERIOR VIEW OF TOOL-OM-ETER
FIG. 2. CROSS-SECTION SHOWING CONSTRUCTION OF TOOL-OM-ETER

Reference to the sectional drawing shows that only one moving element is employed which consists of a weighted piston in the upper or metering cylinder, a small piston in the oil dashpot cylinder, and a rod joining the 2 pistons and extending upward where it moves freely inside the sight glass at the top of the meter.

This rod rises and falls with the pistons so that its height in the sight glass corresponds exactly to the position of the piston in the metering cylinder. A scale plate mounted against the outside of the sight glass permits reading the exact height of the top end of the rod.

Air enters at the lower left-hand opening into the chamber surrounding the dashpot cylinder and passes through ported openings to the interior of the metering cylinder, the wall of which is drilled with a large number of small, accurately reamed holes, uniformly spaced around the cylinder.

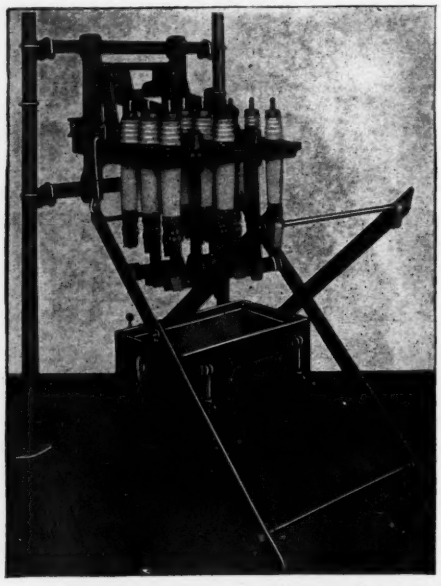
To pass to the outlet chamber, the air lifts the piston and exposes some of the holes to the flow. A small head or difference of pressure is established between the interior of the cylinder and the outlet chamber, this pressure difference, only a few ounces per sq. in., being fixed by the exact weight of the moving element and the area of the piston on which the difference of pressure acts.

The moving element rises until the weight is exactly supported by the difference in pressure, pistons and rod are then following in static balance in a position corresponding exactly to the volume of air flowing, the number of holes exposed and the height of the top of the rod in the sight glass.

The loss of pressure is slight and the meter cannot be injured by flow in excess of its metering capacity. Corrosion of the meter is prevented by the use of bronze parts.

Tank Lifter for Small Size Oil Switches

OIL switch tank lifters are a great convenience, particularly in stations where a large number of switches are installed; and while a tank with oil for a comparatively small switch is not especially heavy, the character of the load makes it somewhat cumber-



TANK LIFTER FOR TYPE F FORM K-13 AND K-5 OIL SWITCHES

some for one man to manage. The result of this is that often the oil switch contacts are not inspected as regularly as they should be to insure the most satisfactory operation.

The tank lifting arrangement manufactured by the General Electric Co. provides a simple and easy means

for quickly lifting an oil switch tank either up or down the entire distance between the switch frame and the floor. The lifter is made in 2 widths, one for single and the other for double-throw switches, and differs only in the lengths of the 3 rods that join the parallel operating arms. This is necessary owing to the difference required in the dimensions of the tanks.

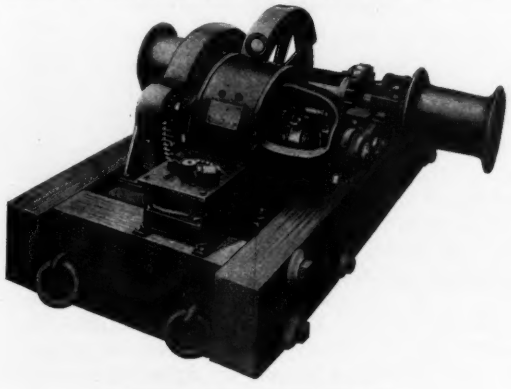
To fasten the tank lifter to the switch frame and lower the tank, 2 hooks attached to the inner ends of the longer pair of operating arms are placed over the ribs of the switch frame, the operating arms are raised and the tank supports fitted under the tank. Then the wing nuts that secure the tank to the frame are turned to unfasten the tank, and the arms are lowered to the floor. Finally, 2 catches on the cross rod between the inner set of operating arms are released, and these arms are raised until the tank reaches the floor.

The tank supports are separate from each other and attach to the tank by continuations of the 2 equal sides of each strap iron triangle, which are bent upward to fit over the rim on the bottom of the tank. Each support is removed by lifting one end of the tank a few inches from the floor and sliding the support from under. To place the tank on the oil switch, the operation as described is reversed.

A Portable Winch

THE construction of the New York Subway necessitated the building of the portable motor-driven winch shown in the illustration. It has, however, since demonstrated its usefulness in many other fields.

When used for lifting material out of the Subway, a trestle or light framework carrying a sheave is placed directly over the opening. The hoisting rope is passed over the sheave, given 2 or 3 turns around the friction drum, the motor started and the slack paid off as the material is hoisted. When used to assist teams in hauling loads up heavy grades, one end of the rope is fastened to the wagon tongue and the other end given several turns around the friction drum. Current is obtained from the 550-v. trolley circuit.



ELECTRICALLY DRIVEN WINCH

The winch is manufactured in 2 sizes by the Dobbie Foundry and Machine Co., Niagara Falls, N. Y. The small outfit operates at a rope speed of 152, and the large one at 178 ft. per min. Westinghouse compound-wound type SK motors rated at 5 and 7½ hp. respectively are used to drive these outfits.

U. S. CIVIL SERVICE EXAMINATIONS will be held on Sept. 15, 1915, as follows: Assistant inspector of boilers; Junior engineer, Engineer Department at large; Laboratory apprentice, Bureau of Standards; Local inspector of boilers.

The following-named examinations will be held on Oct. 13, 1915: Draftsman, Mechanical, Panama Canal Service (men only); Engineer, Indian Service; Junior engineer, mechanical or electrical, Engineer Department at large.

In accordance with an act of Congress, an applicant for examination for a position in the apportioned Departmental Service at Washington, D. C., will be required to be examined in the State or Territory in which he resides, and to show in his application that he has been actually domiciled in such State or Territory for at least one year previous to the examination. This provision does not apply to other services.

Application forms and full information in regard to the above-named examinations may be obtained by addressing the U. S. Civil Service Commission, Washington, D. C., or the Secretary of the Board of Examiners at the following-named places: Boston office, Boston, Mass.; Philadelphia, Pa.; Atlanta, Ga.; Cincinnati, O.; Chicago, Ill.; St. Paul, Minn.; Seattle, Wash.; San Francisco, Cal.; Customhouse, New York, N. Y.; New Orleans, La.; Old Customhouse, St. Louis, Mo.

For information in regard to positions in post offices, customhouses, and other local services, apply to the secretary of the board at any one of the above-named places.

U. S. CIVIL SERVICE COMMISSION announces an examination for ordnance draftsman, on Aug. 4 and 5, 1915, to fill vacancies in this position as they may occur in any United States navy yard or naval establishment or in the Department at Washington, D. C., at entrance salaries ranging from $3.28 to $5.04 a day. The following subjects will have the relative weights indicated: Mathematics (algebra to quadratics, geometry and mensuration of plane figures and solids, elements of plane trigonometry and applied mechanics), 20; materials and shop processes of manufacture, 10; drawing, 30; education, training, and experience, 40. For positions paying $3.28 to $4 a day, applicants must have had 2 yr. engineering course in a technical school and at least 3 yr. experience in the drafting room, or have had the equivalent of a complete course of machine design and drawing in a technical school and not less than 1 yr. of experience in the drafting room; for positions paying $4.08 a day or over, the equivalent of a complete course in engineering in a technical college and at least 3 yr. experience in the drafting room, or a full course in machine design and drawing and at least 5 yr. of drafting room experience, of which not less than 1 yr. must have been spent in design. Age, 18 yr. or over. Applicants must submit to the examiner on the day of the examination their photographs, taken within 2 yr. Apply for Form 1312, stating title, Ordnance Draftsman (Male), to the U. S. Civil Service Commission, Washington, D. C.

THE EFFECT of vanadium in plain carbon-steel castings is to increase the elastic limits about 30 per cent, giving a much higher proportion of available strength for the same ultimate strength.

Book Reviews

THE UNITED STATES GEOLOGICAL SURVEY has just issued a guide book describing the Overland Route from Missouri river to the Pacific coast, and every traveler may now enjoy the luxury of being "personally conducted" without any other expense than the dollar he must send to the Superintendent of Documents at Washington, D. C., to obtain a copy. It is Secretary Lane's desire that the transcontinental journey, by whatever route, shall afford the traveler an intimate acquaintance with the country which he passes, and this volume, therefore, is the first of 4 which will appear in rapid succession. The next to come, that covering the Northern Pacific Route, so closely identified with the Lewis and Clark expedition of 1803-1806, will be published in a few days; and those describing the Santa Fe Route and the Shasta and Coast Route will follow soon.

The value of these guides to travelers interested in their country can not be measured. The route is followed from station to station, and the country along the way described and explained from many points of view. Human history, geologic history, agricultural and mining values—everything, in short, that can make a car-window landscape vital and interesting—is succinctly and rapidly sketched.

The guidebooks are full of items of general interest that will answer such questions as the average intelligent traveler is continually asking. In a broad way the story of the West is a unit, and the aim of this description of the western United States is to meet the needs of the American citizen who desires to understand what he sees.

The route is covered by a series of 29 complete and accurate maps, which are so arranged that the reader can unfold them one by one and keep each map in view while he is reading the text relating to the portion of the route it represents.

The book is also freely illustrated with half-tone plates of some of the most striking views and objects to be seen on the journey and with pictures of prehistoric animals that inhabited the West in ages past, when Nebraska and Colorado, for instance, were huge swamps frequented by strange beasts whose fossil remains are now found in the rocks formed from the sand and mud of the ancient swamps, which have since been elevated thousands of feet. The book of 244 pages is as a whole distinctly popular in character.

In ordering the Overland Route guidebook from the Superintendent of Documents, ask for Bulletin 612 and inclose $1.

"CENTRIFUGAL PUMPS," by R. L. Daugherty, 192 pages, illustrated; 1915, New York. Price, $2.

The extensive use and increasing popularity of centrifugal pumping machinery has made it necessary for many to become familiar with this subject in all its phases. The author of this book has treated the subject of centrifugal pumps in a most comprehensive manner, going largely into the theory of this class of pumps, and in his treatment of the subject, uses higher mathematics freely in order to arrive at desired conclusions in the most direct manner. While the book is somewhat limited in space, the method of treatment makes the subject clear and concise, giving the book a great value to those who are in the designing field.

In the earlier chapters, the author gives definitions, classifications, historical developments, descriptions, and treats installation and operation features of various types of centrifugal pumps; following this by the theory of pumping water by means of rotating pumps, characteristics of pumps delivering against varying heads and subjected to different suction lifts. In other chapters, factors affecting efficiency, comparison of the centrifugal pump with displacement pumps, comparison of different types of centrifugal pumps, and general laws and factors are discussed. Pump testing comes in for a complete chapter, costs are discussed in another, and the book closes with a chapter on design of centrifugal pumps, followed by appendices giving test data and other valuable information.

As previously stated, the book is more suited to those who wish to design centrifugal pumps than to the operator, and would serve admirably as a text book for technical schools with the addition of more problems at the ends of chapters.

LOCATION OF FORD ENGINE TROUBLES MADE EASY, is the name given to a new chart of the Ford engine, by Victor W. Page, which is printed on a sheet 25 by 38 in., showing 4 different views of the engine mechanism, with each part named, and under each type of difficulty the different things which may have caused trouble are carefully tabulated.

Someone has said that "It takes 5 hr. to find the trouble in a gasoline engine, and 5 min. to fix it." This chart is along the line of reducing the most difficult part of any repair operation, since it gives, in logical order, the points to be looked over when any trouble occurs. The price of this chart is 25 cents. It is published by the Norman W. Henley Publishing Co., 132 Nassau St., New York City.

Catalog Notes

IN AN ATTRACTIVE booklet entitled "Experience," the Chas. A. Schieren Co., Schieren Bldg., New York City, has embodied extracts from letters from people who have used and know Duxbak belting, and also a number of illustrations showing important drives in all parts of the world. A valuable formula is that for the horsepower of belting on Lenix drives, which is that the horsepower is equal to the width of the belt, in inches, times the thickness, in inches, times the speed, in feet per minute, divided by 118.

FROM SUNDH ELECTRIC CO., of New York, we recently received description and price list of automatic self starters, brakes, circuit breakers, contactors, elevator controllers, panels, pressure regulators, solenoids, speed regulators, switches and valves.

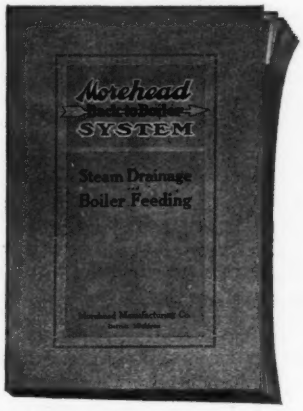
THE LATEST BULLETIN, No. 1002, of American Roller Bearing Co., Pittsburgh, Pa., describes in detail the design and construction of roller bearings which the company is producing for power transmission appliances.

ALLIGATOR STEEL LACING is illustrated in a new folder from Flexible Steel Lacing Co., 522 S. Clinton St., Chicago.

THREE PIECES of educational literature have recently been published by the Diamond Power Specialty Co., Detroit, Mich.

One entitled A Consulting Engineer Asks a Question, shows the improvements that have been made in the Diamond Soot Blower System for hollow staybolt boilers and the advantages of having the entire system in the front of the boiler, as in the Diamond End Soot Blower System. Pamphlet No. 2 is a treatise on the advantages of clean tubes in fire-tube boilers and shows how the Diamond Front End soot blower fills the need for a blower of this type; also the actual savings to be accomplished by the use of the Diamond blower. The third circular, which shows the Diamond Soot Blower for water-tube boilers, is specially interesting, giving details of construction and data from operating tests. Any or all of these pamphlets will be gladly sent to anyone who is interested in greater economy and efficiency in the power plant.

MOREHEAD tilting steam traps, return, nonreturn, vacuum and condenser, comprising the Morehead Back to Boiler System, are described in a catalog recently received and illustrations show the application of the



Morehead Back to Boiler System in office buildings, automobile factories, refineries, etc. Before and after temperature charts show the comparison in coal consumption. The manufacturer is Morehead Mfg. Co., Detroit, Mich.

COMBUSTION ENGINEERING CORPORATION, of New York City, in a new catalog, Bulletin B-2, describes its Type E stoker, showing the details of the construction, method of underfeeding at the center of the furnace, with motion of the fuel sidewise down inclined grates towards the sides of the furnace. It gives a full description of the stoker, and shows the application to different types of boilers.

THE WESTINGHOUSE Electric & Mfg. Co. recently published descriptive leaflet No. 2322-C covering its complete line of type AR single-phase motors; and descriptive leaflet No. 2362-C illustrating and describing their line of type CA single-phase small motors for use in the home, office and shop.

July issue of the Show Window Calendar, a monthly publication issued by the Westinghouse Electric & Mfg. Co., to assist distributors of their electric ware, contains suggestions especially suitable for the Fourth.

THE 1915 ISSUE of Catalog J, of the National Tube Co., Pittsburgh, Pa., is a storehouse of information on tubes, piping, fittings and valves. It includes sizes and prices of every conceivable kind of device in these classes, making a book of 450 pages, handsomely printed in black, green and yellow on heavy coated stock and with durable cloth binding.

It includes the specialties manufactured by the Kewanee Works, National Tube Co., as well as the other products of the company, making a line so extensive that the index embraces some 1800 entries. It is too expensive a volume for indiscriminate distribution, but executives who have real use for it may well write the National Tube Co. for a copy.

FROM ENGBERG'S Electric & Mechanical Works, of St. Joseph, Mich., we have received a new Bulletin No. 101, of direct-current generating units from 1 to 50 kw. The bulletin gives a complete description of the details of the generator and engine, fully illustrated

and handsomely printed, with dimensions and weights of all units. It is a catalog which will be of interest to all who wish to study the construction of direct-current machinery and of moderate size vertical engines, as the detail illustrations are clear and instructive.

THE SANITARY DISPOSAL of Municipal, Institutional and Industrial Waste is the subject of a pamphlet from The Jarvis-Morse Corporation, 90 West St., New York. The Morse destructor furnace is described and illustrations show its use in cities, U. S. Navy yards, business buildings, etc.

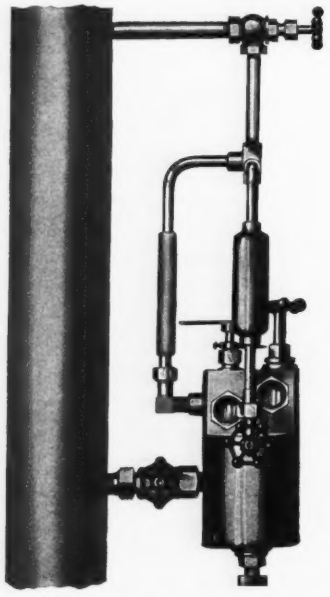
Trade Notes

A 42-IN. TWIN WATER STRAINER is being built for the Toledo Railways & Light Co., by the Elliott Co., Pittsburgh. This is one of the largest twin strainers ever built, and is of particular interest because of the motor-drive attachment, by means of which the valves are operated so as to direct the flow of water through either compartment of the strainer.

The usual practice with motor-operated twin strainers is to mount the motor direct on the side of the

strainer; but in this case, the strainer is likely to be submerged for short times during the flood seasons, and the motor together with its controlling apparatus, reduction gears, etc., is suspended from the ceiling overhead, the power being transmitted to the valves through vertical shafts, one for each of the 2 valve screws.

A NEW and improved type of drop feed grease lubricator, known as "Class D," is now being offered to customers of The Ohio Grease Co., Loudonville, Ohio. It is extremely simple and neat, and contains many points of refinement, such as close feed regulation, small drops, fine atomization, insulated tubes, protected sight glasses, etc. Reports show that it is giving even better service than the lubricators this company has put out



in the past. This new instrument, like the others, is not sold, but is loaned and kept in repair free for the purpose of feeding Ohio cylinder grease, which, also, has been greatly improved recently through the discovery of better raw materials and new methods of compounding. The company reports that the combination of this new lubricator and better grease has resulted in unvarying success wherever they are used.

THE McCORD MFG. CO., of Detroit, has just received a letter from Sid. L. Monroe, engineer of The Majestic Milling Co., at Aurora, Mo., in which he relates a remarkable experience involving McKim gaskets. That part of his letter which is particularly gratifying to the McCord people follows:

"You will remember that you had to show me in 1911, when I received a sample gasket. Your Order No. G-7957, date 2-8-11. The *same* gasket is still in service and has been every day since under a pressure of 170 lb."

The company sends free samples, prepaid, to those sufficiently interested to write for them (giving size and purpose).

PRACTICAL ENGINEER
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Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Display

Full page, one year, each insertion, $60.00.

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No display type allowed, but the first three words may be set in capital letters.

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Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—By young man with 10 years' practical experience from boiler room up. Hold first class Massachusetts engineer's license. Will go anywhere. Am total abstainer and can furnish A1 references. Address Practical Engineer, Box 393, Chicago, Ill. 8-1-1

POSITION WANTED—By young man, age 22, as oiler or helper in power plant. A. S. C. student. Sober. Good references. Address R. W. Peterson, 1041 S. Euclid Avenue, Oak Park, Ill. 8-1-1

POSITION WANTED—As chief engineer in small plant or assistant in large plant. At present holding a state position. Am capable of handling steam, electric and ice machines. Can do my own steam and water fitting and also all repairs called upon to do. Can give references. Willing to go anywhere. Address Practical Engineer, Box 397, Chicago, Ill. 8-1-1

POSITION WANTED—By engineer in medium sized power plant or helper in large one. Have third class Ohio license. 5 years' experience with steam engine and boilers. Some experience with electricity. Good habits. Sober. 25 years old. Good reference. Address Emmett R. Ralston, Box 43, Cheshire, Ohio. 7-1-3

POSITION WANTED—By engineer in medium sized power plant, or large coal mine. Have Illinois license; 7 years' experience with steam engines and boilers. Some experience with electricity. Good habits. References. 24. Illinois preferred. Address W. E. Rohline, Box 224, Farmington, Ill. 8-1-1

POSITION WANTED—By engineer, 8 years' experience with steam and electric. Understand gas engines and refrigeration. Temperate, reliable, married man. Member N. A. S. E. Address W. H. Snyder, 53 Brown St., Hartford, Conn. 8-1-1

POSITION WANTED—By engineer with years of experience in ice and electric light plants. Understand both a.c. and d.c. machines. Am a graduate of one of the best colleges in Middle West. A1 references. Ezra D. Dumas, Clarinda, Iowa. 8-1-1

POSITION WANTED—Engineer, 47, New York; ambitious, with practical ideas, also technical experience. 7 years in charge in present position wishes to make change. Position where economy and efficiency is appreciated, preferred. Address Practical Engineer, Box 400, Chicago, Ill. 8-1-1

POSITION WANTED—As engineer in small town. Have had thirteen years steam and electrical experience; practical machinist. James Doelzel, 3121 W. 26th St., Chicago, Ill. 8-1-1

POSITION WANTED—By young man as oiler or fireman in a modern plant. I. C. S. graduate. Address Frank Knapp, 404 So. 5th St., St. Joseph, Mo. 8-1-2

Help Wanted

WANTED—An operating engineer for an industrial power plant consisting of both Refrigerating Systems, Air Compressors, Belt Driven A.C. Generators, etc. Alternate shifts. Steady work. $120.00 to start. First-class chance for advancement. Location, northern Wisconsin. Address Practical Engineer, Box 399, Chicago, Ill. 7-15-3

FREE ENGINEER BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

ENGINEER—Good all around operating experience and pleasing personality for road work; no selling. $1500 to $1800 and expenses to start. Permanent. Applicants must be in or near Chicago. Apply The Engineering Agency, Inc., 1601-1662 Monadnock Block, Chicago. 7-15-3

REPRESENTATIVES to cover territory more thoroughly. Boiler-room necessities; liberal commissions; old-established house. Apply by letter. H. F. Maurel, 534 West 22nd St., New York City. 7-15-6

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Calif.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Calif.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WANTED—Agents to handle adding Pump Counters. Big commission paid. Address Box 302, Marshall, Minn. 7-15-3

WANTED—A live concern, having machine shop and foundry, to make and market a stoker designed on correct principles, on a royalty basis. Can be used on boilers, iron and steel heating furnaces, air furnaces, etc. Address Box 398, Practical Engineer, Chicago, Ill. 7-15-2

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried, and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

FOR SALE—150-hp. HRT boiler, 4 yr. old, 125-lb. pressure, $400; 10 by 30 Hewes & Phillips Corliss engine, $325; 16 by 36 Fishkill Corliss engine, $500; 20 by 42 Watts-Campbell Corliss engine, $600; 125-kw. Crocker-Wheeler, 230-volt, direct-connected Allis Corliss engine, $1750; 50-kw. General Electric, 230-volt, direct-connected Harrisburg side-crank engine (one year old), $800. Duzets & Son, 50 Church St., New York, N. Y.

FOR SALE—Grobet Swiss Files are the standard of excellence of files, and have been for over 100 years. We send, postpaid, as an introduced, 48 files especially adapted for tool makers and machinists, on receipt of $5.00. This is a chance to get a set of files you'll appreciate and we'll get future orders. Montgomery & Co., 101 Fulton St., New York, N. Y. tf.

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

A. P. CONNOR, consulting electrical and mechanical engineer, attorney-at-law and solicitor of patents and trade-marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL; 175 pages; gilt edges; bound in leather; edited by University of Tennessee; will be mailed every subscriber sending in one NEW subscription (not your own) to Practical Engineer.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

Inventions

INVENTIONS WANTED—Cash or royalty paid if available. Adam Fisher Mfg. Co., D175, St. Louis, Mo. tf.

Sparks From The Advertising Pages

"Truth in Advertising is bound to build up a reign of confidence whose contagious influence will better all the race"

Thus eloquently proclaimed John Temple Graves, the editorialist, in a remarkable address exalting advertising and declaring it the harbinger of progress and eternal betterment.

The occasion was the recent advertising convention in Chicago when fifty churches of all denominations threw open fifty pulpits to fifty chosen business men sent by the Associated Advertising Clubs of the World to proclaim the new righteousness in trade — the new principles of business practice — and the new and better spirit in the commercial world.

Space does not permit the publishing of this splendid address in full, but the following paragraphs are abstracts from it and are well worth reading and assimilating.

"Only five years ago," said Mr. Graves, "the Associated Advertising Clubs struck the higher note of service and improvement and only three years ago the ringing shibboleth of 'Truth in Advertising' caught and crystallized the character and purpose of an ever-strengthening body of virile business men.

That stirring battle cry caught the hearts of a host of as vital figures as ever moved in trade, and has revolutionized and broadened and bettered the policies of a mighty section of the business world.

Met in the beginning with discouragement and the charge of idealism — told that the dream of honest advertising could never realize and that the mission was beautiful but hopeless, these splendid idealists of advertising persevered. They selected from the best and bravest of their association a vigilance committee whose work was planned and prescribed. That vigilance committee went to work like heroes. For three long years they challenged every fraudulent, immoral or lying advertisement that showed its face in newspaper, magazine or poster. It halted every sinner against honest statement and haled to judgment every business hypocrite that sought to deceive the public.

They were the pioneers of the better day, the men who made that vigilance committee. They were soldiers of conviction; they were heroes of the truth in trade. They have done the state and society a mighty service and we know it.

For through them and their imperishable work this organization tells the American public upon the firm basis of statistics the inspiring fact that 90 per cent of *the advertisements which are printed in America today are true and accurate and reliable!* And that the 10 per cent will yet be won to truth.

This revolution deserves to rank with the foremost forward movements of the time. The consumer and the seller of goods and products make up nine-tenths of the human family in our time. The whole tendency of this great reform is to bring this mighty mass together in confidence and mutual interest. *Truth in advertising* is bound to build up *a reign of confidence* whose contagious influence will better all the race.

Under its influence the consumer will learn to trust public prints, and under its standards advertising will deserve to reap a golden harvest of reward — from all classes of those who sell and multiply its clients among all the great bodies who have policies to preach and great truths to disseminate."